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U.S. Army Toxic and Hazardous Materials Agency  
**ENHANCED  
PRELIMINARY  
ASSESSMENT REPORT:**

Navajo Depot Activity  
Bellemont, Arizona

March 1990

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Prepared for:

U.S. Army Toxic and Hazardous Materials Agency  
Aberdeen Proving Ground  
Maryland 21010-5401

Prepared by:

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Under the supervision of:

Environmental Assessment and  
Information Sciences Division  
Argonne National Laboratory  
Argonne, Illinois 60439

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# U S A T H A M A

U. S. Army Toxic and Hazardous Materials Agency

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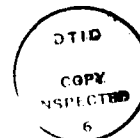
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) <p>Ebasco Environmental conducted an enhanced preliminary assessment (PA) of the Navajo Depot Activity (NADA), Bellemont, AZ. The objectives included identifying and characterizing areas requiring environmental evaluation (AREEs), identifying areas or operations that may require a site investigation, immediate remedial action, or no additional investigation, and identifying other actions necessary to address and resolve all known environmental problems and concerns that may present impediments to the expeditious transfer of all or parts of this property. This PA relied on information readily available from previous studies, outside agencies, and NADA files. AREEs are discussed according to type of operation. Conclusions are drawn about known and suspected releases to soils, groundwater, surface water, and air. Areas of no known environmental problems are shown. Recommendations are made concerning additional investigations needed to resolve issues of concern at several AREEs.</p> <p>Past studies have reported groundwater and/or soil contamination in areas associated with Ammunition Workshops, Ammunition Demolition Areas, the former Landfill, and underground fuel storage. A closure action is presently underway for the Ammunition Deactivation Furnace and its associated ash pile. A small drum disposal site is recommended for prompt action.</p>					
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## LIST OF ABBREVIATIONS AND ACRONYMS

2,4-D	2,4-dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
ADWR	Arizona Department of Water Resources
ANG	Arizona National Guard
ANL	Argonne National Laboratory
AREEs	areas requiring environmental evaluation
arith	arithmetic
AZ	Arizona
CBR	Chemical, Biological and Radiological
CCC	Civilian Conservation Corps
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CG	phosgene
CH	Commercial Heavy zoning classification
CK	cyanogen chloride
cm	centimeter
CN	tearing agent
CO	carbon monoxide
CS	riot control agent
DARCOM	U.S. Army Material Development and Readiness Command
DDT	dichlorodiphenyltrichloroethane
DESCOM	U.S. Army Depot System Command
DLA	Defense Logistics Agency
DNB	dinitrobenzene
DNT	dinitrotoluene
DPDO	Defense Property Disposal Office
DRMO	Defense Reutilization and Marketing Office
DWSP	Drinking Water Surveillance Program
EBASCO	Ebasco Environmental
EDGE	Engineering Design and Geosciences Group, Inc.
EOD	Explosive Ordnance Detachment
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
ft	foot
G	General zoning classification
gal	gallon
geo	geometric
GSA	General Services Administration
GW	groundwater
H	mustard
ha	hectare
HC	hexachloroethane
HDR	HDR Engineering, Inc.

HE	high explosives
HMX	cyclotetramethylene trinitramine
hr	hour
IRP	Installation Restoration Program
ISSA	Interservice Support Agreement
kg	kilogram
km	kilometer
km <sup>2</sup>	kilometer squared
KVA	Kilovolt-Amps
lb	pound
mg/kg	milligrams per kilogram
mg/l	milligram per liter
mi <sup>2</sup>	miles squared
ml	milliliter
mm	millimeter
NADA	Navajo Depot Activity
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
OB	open burning
OD	open detonation
OS	Open Space and Conservation zoning classification
oz	ounce
PA	preliminary assessment
PCB	polychlorinated biphenyl
PM-10	particulate matter with diameters of 10 microns or less
ppm	parts per million
PSD	prevention of significant deterioration
PVC	polyvinyl chloride
PWP	plasticized white phosphorus
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylene trinitramine
SCS	U.S. Department of Agriculture - Soil Conservation Service
SO <sub>2</sub>	sulfur dioxide
SPCCP	Spill Prevention, Control, and Countermeasure Plan
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
TEP	toxicity extraction procedure
TNB	trinitrobenzene
TNT	trinitrotoluene
TSP	total suspended particulates
µg/g	microgram per gram
µg/l	microgram per liter
µg/m <sup>3</sup>	microgram per meter cubed
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USFS	U.S. Forest Service

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USP&FO	U.S. Property and Fiscal Officer
UST	underground storage tank
UXO	unexploded ordnance
WETS	weekend training site
WP	white phosphorus
WQARF	Water Quality Assurance Revolving Fund

## SUMMARY

Ebasco Environmental (EBASCO) has performed an enhanced preliminary assessment (PA) under the supervision of Argonne National Laboratory (ANL) for the Navajo Depot Activity (NADA), Bellemont, Arizona. The PA was carried out in support of the anticipated closure and realignment of NADA. This closure and realignment was directed by the Defense Authorization Amendments and Base Closure and Realignment Act, Public Law 100-526.

The PA is based on NADA information made available to EBASCO from NADA records, previous environmental studies, interviews with knowledgeable current and former NADA personnel, and personal observations of EBASCO investigators and on relevant information on the NADA vicinity obtained from appropriate regulatory and informational agencies. The objectives of this assessment include identifying and characterizing all areas requiring environmental evaluation (AREEs), identifying areas of environmental contamination that may require immediate remedial actions, identifying additional investigations that may be necessary in order to resolve all identified environmental problems, and identifying other environmental concerns that may present impediments to the expeditious transfer of this property.

NADA is located at Bellemont in Coconino County in north-central Arizona, 12 miles west of the city of Flagstaff. The facility encompasses 28,347 acres and is situated on heavily forested to grassy, gently rolling to steep hilly terrain at approximately 7,100 ft above mean sea level (msl) on the Colorado Plateau. The climate is semi-arid and surface water is ephemeral and occurs intermittently, except for several perennial springs which are the primary water supply source. NADA is mostly surrounded by undeveloped, multiple-use National Forest land managed predominantly for grazing, recreation, and timber, with some light commercial and residential zoning to the north. The facilities present at NADA include approximately 170 buildings of which 32 are currently used for administration, maintenance, operations, and storage located mostly in the north-central portion, approximately 776 igloo structures used for conventional and formerly chemical munitions storage in the central portion, a demolition area in the southern portion, and buffer zones along the eastern and western borders of the base.

The installation, created from former National Forest and a small amount of privately owned land in response to U.S. entry into World War II, has functioned since 1942 as a supply depot providing storage and limited maintenance of assigned commodities. Since 1982 NADA has been operated by the Arizona National Guard (ANG) through an Interservice Support Agreement (ISSA) under the overall Command of Tooele Army Depot. In addition to personnel assigned to carry out the supply depot mission, the ANG operates the Weekend Training Site (WETS) on land around the Bellemont Armory, a small inlier property owned by the State of Arizona.

Past and present missions have required the storage, handling, use, and disposal of a variety of hazardous substances and wastes. The resulting storage, operation, and disposal practices have led to some known and suspected contamination of several environmental media, including soils, groundwater, surface water, and structures. Several present operations and disposal practices are regulated under environmental permits or have had permit applications

submitted with permit approval pending. At this time there are ongoing investigations or closure actions addressing some previously identified environmental problems.

The AREEs identified in this report have been grouped according to mission elements in the following categories: ammunition demolition area, ammunition workshops, munitions storage, munitions testing and training areas, operations facilities, hazardous materials storage, solid waste disposal, and facility-wide AREEs. AREEs in these categories have been assessed in terms of their potential to have had contaminants released to the environment. The groups are discussed below, and information about individual AREEs is summarized in Table S-1 at the end of this section.

Ammunition Demolition Area operations have been shown to have locally contaminated soils with metals, explosives-related residues, and potentially unexploded ordnance (UXO). Based on the location, surficial nature, and character of soil contamination, it is suspected that surface water could potentially be contaminated during infrequent storm-related runoff events. Monitoring wells completed in the area are too shallow to encounter groundwater, so it is unknown if soil contamination has migrated to any of the underlying perched water table zones. Ongoing demolition activities in the Demolition Area are operated under Resource Conservation and Recovery Act (RCRA) interim status based on the filing of a RCRA Part A application.

Past operations at the largely inactive Ammunition Workshop Area have released contaminants to soils and groundwater and possibly to surface water. Investigations of soil and groundwater contamination have been conducted in this area and a closure plan for the Deactivation Furnace and its Ash Disposal Pile is soon to be implemented.

Current munitions storage presents little threat to the environment. Past storage may have released dusts from explosive compounds to the interiors of munitions storage structures. Past spills from leaking chemical munitions may have released agent degradation products to interiors of structures and surrounding soils. Testing is required to determine if these suspected problems exist prior to release of any of the potentially affected structures for unrestricted use.

Munitions testing sites potentially contain UXOs, explosives residues, and metal debris contamination in structures and soils. Investigation is required for affected areas prior to closure and unrestricted property release.

Certain operations facilities including vehicle and equipment maintenance operations have likely impacted structures and soils and possibly impacted surface water and groundwater in several specific areas associated with them. Most of these releases are a result of past disposal and practices. Prior to unrestricted release and closure, some investigation would be required.

Past hazardous materials storage has, through spills and handling procedures, released contaminants to the environment. Investigation of past and present storage sites, including those with known spill sites, would be required prior to unrestricted release of areas where storage activities took place.

Records indicate the Former Sanitary Landfill received virtually all types of solid wastes generated by NADA from its inception until 1966. Groundwater downgradient from the Former Sanitary Landfill has been found to contain evidence of leachate. The recently identified Igloo Area C Drum Site contains three drums, which may be releasing contaminants to the surrounding soils. Although there is low potential for human exposure and moderate potential for wildlife exposure, the uncontained nature of this small site suggests that it should receive immediate action. Other solid waste disposal areas have not been sampled.

Several facility-wide AREEs have been considered. Comprehensive surveys for asbestos and lead-based paints have not been conducted. However, it is known that asbestos has been released to the environment as a result of the deterioration of structures and facilities. A radon survey is scheduled to commence in early 1990. Preliminary inventories of underground storage tanks (USTs) and polychlorinated biphenyl- (PCB) containing transformers have been completed. The overall hazard from these dispersed substances is not fully known at this time.

Areas with no known environmental problems are located along the western and eastern margins of NADA in areas generally maintained in the past as buffer areas to mission operations. Consideration of all or parts of these areas for unconditional release is dependent on the results of a visual inspection and surface sweep in areas where only training activities have taken place. Release of other areas of NADA would require initiation of other needed investigations and subsequent formulation of proper closure plans for AREEs, in addition to completion of ongoing investigations and closure plans. Currently, the Army has no plans to release the land at NADA for unrestricted use. The ANG will continue to operate NADA for training purposes.

Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Old EOD Demolition Area	NADA-5	Demolition activities from 1942 to 1945 and in 1961	UXO's, Metals, Explosives - related compounds, White phosphorus	Former Air	Soil	Potential soil contamination and UXO's	Clear UXO's, site investigation and closure
Explosives Demolition Area	NADA-11	Detonation of conventional explosives	UXO's, Explosives - related compounds, Metals	Air	Soil	Potential soil contamination and UXOs	No action with continuing use by ANG
Former WP Detonation/Burn Area	NADA-7	Former area for detonation and burning of WP, suspected disposal of leaking mustard bombs	TNT, Nitrate/nitrite, Phosphorus	Soil Former Air		Sampling has detected soil contaminants	Site investigation and closure
Former CK/CG Demilitarization Area	NADA-9	CK and CG bombs formerly vented to the atmosphere		Former air		Unstable nature of agents makes residual contamination unlikely	No action
Open Burning Area	NADA-12	Burning of explosive contaminated materials	Explosives - related compounds, Metals	Soil Air		Sampling has detected soil contaminants	No action with continuing use by ANG
OB/OD Waste Pile & Burn Area	NADA-10	Burning and landfilling of waste materials	Explosives - related compounds, Metals	Air	Soil	Probable soil contamination	No action with continuing use by ANG

\*SWMU - Solid Waste Management Unit as previously designated by USAEHA (1987)

GW - groundwater

SW - surface water

Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Closed TNT Retention Ponds	NADA-3	Former site of TNT wastewater disposal by drying and burning	Explosives - related compounds	Soil Former Air	Former GW	Sampling has detected soil contaminants	Site investigation and closure
Former Open Burning Areas	NADA-6 NADA-8	Former disposal and burning of wastewaters.	Explosives-related compounds, Metals, Others unknown	Former Air	Soil Former GW	Probable soil contamination from disposal and burning	Site investigation and closure
Pad #3		Site of former sodium arsenite leak and former burning activities	Sodium arsenite, Explosives-related compounds, Metals	Former Air	Soil	Possible soil contamination	Site investigation and closure
Closed Open Burning Areas	NADA-4 NADA-18, NADA-19, NADA-20	Former open burning of propellants and explosives - contaminated materials	Explosives - related compounds, Metals	Former Air	Soil	Probable soil contamination from burning	Site investigation and closure
Former TNT Washout and Laundry Buildings		Former washout facilities and laundering of TNT - contaminated clothing	Fuel- and explosives - related compounds, Metals	Soil GW		Buildings and surrounding soil contaminated, leaking UST at Laundry	Site investigation and closure
Former TNT Wastewater Lagoons & Old Earth Reservoirs	NADA -1	Former Discharge of TNT contaminated wastewater	Explosives - related compounds, Metals	Soil	Former SW Former GW	Sampling has demonstrated soil contamination	Site investigation and closure

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GW - groundwater  
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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Former Deactivation Furnace, Ash Disposal Pile, and Ash Storage Building	NADA-13 NADA-14 NADA-34	Former demilitarization furnace and residual ash	Fuel- and explosives - related compounds, Metals	Soil Former Air	GW	Sampling has shown soils contamination from deactivation operations and leaking fuel pipes	Proceed with RCRA closure work at this site
Former Ammunition Workshop Buildings		Former ammunition maintenance and renovation	Explosives-related compounds, Paints, Metals, Acids	Former Air	Soil	Buildings and surrounding soil potentially contaminated	Site investigation and closure
Current Ammunition Workshop		Minor ammunition maintenance	Explosives - related compounds, Paints, Metals, Acids	Air		Buildings potentially contaminated	No action with continued use by ANG
Igloos and Standard Magazines including D-200 and D-300 series		Conventional munitions storage	Explosives - related compounds		Soil	Igloo interiors and soil at drain outlets are potentially contaminated	No action with continued use by ANG
D-200 Series Igloos		Former storage of mustard-filled bombs	Mustard breakdown products		Soil	Igloo interiors and soil at drains outlets potentially contaminated	Site investigation and decontamination
D-300 Series Igloos		Former storage of CK- and CG-filled bombs				Unstable nature of compounds makes residual contamination unlikely	No action

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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Former Chemical Laboratory	NADA-2	Foundation of former CK and CG testing laboratory	Soluble inorganic salts, Other chemicals	Former Air	Soil	Potential soil contamination at drain outlet	Soil sampling at drain outlet
Pyrotechnic Range		Former surveillance testing of conventional munitions	UXOs, Metals, Explosives-related compounds	Former air	Soil	Potential soil contamination at site	Clear UXOs, site investigation and closure
Surveillance Workshop Area		Surveillance testing in building and possibly surrounding area	Explosives-related compounds, Metals		Soil	Building and possibly surrounding area potentially contaminated	No action with continued use by ANG
Training in Buffer Areas		Training exercises and bivouacs				Minimum impact on Buffer Areas	No action with continued use by ANG, visual inspection and surface sweep of Buffer Areas prior to unrestricted release
Old and New Firing Ranges	NADA-16	Former small arms range in Cinder Pit 3, current firing range in West Buffer Area	Metals		Soil	Generally non-mobile metals in soil from bullets and spent casings	No action for current facility, Cinder Pit 3 addressed with landfills
Vehicle and Locomotive Maintenance Shops	Includes NADA-30	Repair and maintenance operations including outfall from steam cleaning operations	Petroleum products, Solvents, Acids, Metals	Soil	Former SW	Structures and surrounding soil potentially contaminated, storm sewer drainage ditch contaminated	Investigation and closure of storm sewer drainage ditch, determine if NPDES permit required for discharge to ditch
Paint Shop and Paint Storage Buildings		Painting and drying operations vented to atmosphere	Paints, Solvents	Air		Structures potentially contaminated by leaks and spills	No action with continued use by ANG

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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Wastewater Treatment	NADA-22 NADA-23	Treatment plant, sludge drying beds, and wastewater lagoons	Heavy metals	Former SW	Soil GW	No inordinate environmental threat from routine operations	No action
Former Indian Village Wastewater Treatment	NADA-33	Inhoff tank and three sewage lagoons	Heavy metals		Soil Former GW	Household waste only - no significant hazards	No action
Former and Current Asphalt Plants		Current plant periodically used for training purposes	Petroleum products	Air	Soil	Probable soil contamination	Investigation and closure of former plant site
Former Hospital		Former hospital in WETS complex	Heavy metals, Mercury, Biological waste, Solvents			Certain portions of building potentially contaminated	Wipe samples of structure for closure plan
Former Mercury Storage Warehouse		Concrete foundation pad for former warehouse	Mercury	Air	Soil	Concrete pad and surrounding soil potentially contaminated	Site investigation and closure
Igloos H-111 and B-121		Mercury storage	Mercury	Air		Igloo H-111 interior potentially contaminated by a spill	Investigation and sampling
Igloo H-118	NADA-21	Former waste pesticide storage	Pesticides		Soil	Igloo and soil at outside drains potentially contaminated	Investigation and closure of igloo and soil at igloo drains

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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Former Pesticide Storage Building 335		Former storage of pesticides within and outside of building	Pesticides		Soil	Building and surrounding soil potentially contaminated	Investigation and closure of building and surrounding area
Current Pesticide Storage Building 244		Building with no utility hookups in Warehouse Area	Pesticides			Building does not meet Army standards for pesticide storage	Installation of power, water, spill control, and firewalls
Igloos F-306 and F-307		Former tritium storage	Radioactive materials			Certified as free of radioactive contamination	No action
GSA Warehouses		Tannin and former asbestos storage	Asbestos, Tannin		Soil	Buildings and surrounding soil potentially contaminated	Include in asbestos survey
Former Open Air Storage Area		Unbermed gravel area with some 55 gallon drums still present	Oils, Fuels, Paints, Thinners, Antifreeze		Soil	Potential soil contamination from leaks and spills	Site investigation and closure
Current Open Air Storage Area	NADA-28	Fenced unbermed gravel site in Administration Area	Oils, Fuels, Paints, Thinners, Antifreeze		Soil	Potential soil contamination from leaks and spills	Improve spill containment features of area
Former Sanitary Landfill	NADA-17	Received many types of waste from 1940's to 1966	Nutrients, Zinc, TNT, TNB, Polynuclear aromatic hydrocarbons	GW Soil Former Air		Sampling has demonstrated soil contamination and leachate in the alluvial aquifer	Additional investigation and closure of site

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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Cinder Pit 3	NADA-16	Landfill and former pistol range	Waste oils, Metals, Unknown others		Soil	Landfill contains undocumented materials	Site investigation and closure
Construction Debris Landfill	NADA-25	Landfill in former limestone extraction pit	Asbestos		Soil	Buried construction materials do not pose a hazard	No action
Former Construction Debris Landfills	NADA-27 NADA-32	Construction materials mostly covered by soil	Asbestos		Soil	Buried construction materials do not pose a hazard	Add cover soil to close sites
Drum Burial Site in Demolition Area		Possible burial of 20-25 drums	Herbicide or Acid		Soil	Unclear if drums were full or empty when buried	Site investigation and closure
Quarry Tank Area	NADA-15	Waste materials formerly dumped in limestone quarry pits	Metals		Soil	Large quantities of metals and other debris dumped when NADA constructed	Disposal of surface debris in approved landfill
Construction Debris Waste Pile	NADA-24	Two piles of construction materials	Asbestos, Metals		Soil	Uncontained asbestos disposal in waste pile	Disposal of surface debris in approved landfill
Warehouse Area Waste Pile	NADA-26	Waste materials on concrete pad and adjacent ground	Metals, Grease, Drummed materials		Soil	Soil potentially contaminated by waste pile materials	Disposal of surface debris in approved landfill, soil investigation
Diesel and Gasoline- Contaminated Soil Piles		Excavated soil from UST remediations placed on concrete pads	Fuels	Air	Soil	Volatilization and potential soil contamination	No action while land farming treatment ongoing

\*SWMU - Solid Waste Management Unit as previously designated by USEPA (1987)

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Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Igloo Area C Drum Site		Drums and other waste materials on surface	Herbicide, PCBs		Soil	Uncontained possible hazardous materials and contaminated soil	Immediate action to limit access, investigate, and clean up site
Administration Area Incinerator		Building 37, a fireplace-like structure		Former Air		Probable use for burning paper materials	No action
Asbestos		Used as insulator and in building materials	Asbestos	Soil Air		Asbestos insulation is in disrepair and is releasing to the environment	Conduct planned survey, plan and conduct remediation of problem sites
Polychlorinated Biphenyls	NADA-31	PCBs in transformer oils	PCBs		Soil	Storage in Building S-18, potential spill near deactivation furnace	Site investigation of potential PCB spill, no action for continuing storage in Building S-18
Radon		Potential radon gas buildup in structures	Radon			Survey scheduled for early 1990	Conduct planned survey and remediate any exposure hazards
Underground Storage Tanks		Known and potential unknown USTs, leaks at Buildings 27, 31, 316, and 334	Fuels	GW Soil SW		Tanks and contaminated soil at Buildings 27 and 31 removed, other sites still to be addressed	Conduct planned remediation for Building 334 leak, site investigation and closure of UST at Building 316, inventory and closure of other USTs

\*SWMU - Solid Waste Management Unit as previously designated by USAEHA (1987)

GW - groundwater  
SW - surface water

Table S-1 Summary of Areas Requiring Environmental Evaluation (AREEs)

AREEs	SWMU* Number	Description	Suspected Contaminants	Releases to Media		Conclusions	Recommendations
				Known	Suspected		
Lead-Based Paint and Solder		Lead present in paints and water pipe solder	Lead			No problem with lead in water supply, lead paint no longer used but may be exposed in buildings with children	Conduct inventory or survey especially in housing area

General Recommendation:  
Design and conduct a NADA-wide comprehensive baseline hydrogeologic investigation.

\*SWMU - Solid Waste Management Unit as previously designated by USEPA (1987)

GW - groundwater

SW - surface water

## 1.0 INTRODUCTION

In October 1988, Congress passed the Defense Authorization Amendments and Base Closure and Realignment Act, Public Law 100-526. This legislation provided the framework for making decisions about military base closures and realignments. The overall objective of the legislation is to close and realign bases in order to maximize savings without impairing the Army's overall military mission. In December 1988, the Defense Secretary's ad hoc Commission on Base Realignment and Closure issued its final report nominating candidate installations. The Commission's recommendations, subsequently approved by Congress, affect 111 Army installations, of which 81 are to be closed. Among the affected installations is Navajo Depot Activity (NADA).

Legislative directives require that all base closures and realignments be performed in accordance with applicable provisions of the National Environmental Policy Act (NEPA). As a result, NEPA documentation is being prepared for all properties scheduled to be closed or realigned. The Base Closure Division of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) is responsible for supervising the preliminary assessment effort for all affected properties. These USATHAMA assessments will subsequently be incorporated into the NEPA documentation being prepared for the properties.

This document is a report of the enhanced preliminary assessment (PA) conducted at NADA by Ebasco Environmental (EBASCO) for Argonne National Laboratory (ANL) under contract to USATHAMA.

### 1.1 AUTHORITY FOR THE PA

USATHAMA has engaged ANL, who has retained EBASCO, to assess the environmental quality of several installations proposed for closure or realignment. Preliminary assessments are being conducted under the authority of the Defense Department's Installation Restoration Program (IRP); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 91-510, also known as Superfund; the Superfund Amendments and Reauthorization Act of 1986, Public Law 99-499; and the Defense Authorization Amendments and Base Closure and Realignment Act of 1988, Public Law 100-526.

In conducting preliminary assessments, ANL and EBASCO have followed the methodologies and procedures outlined in U.S. Environmental Protection Agency (EPA) Directive 9345.0-01, "Preliminary Assessment Guidance for Fiscal Year 1988," issued by the Office of Emergency and Remedial Response (EPA, 1988). Consequently, this PA addresses all documented or suspected incidents of actual or potential release of hazardous or toxic constituents to the environment.

In addition, this PA is "enhanced" to cover topics not normally addressed in a preliminary assessment. Specifically, this assessment considers and evaluates the following topical areas and issues:

- Status with respect to regulatory compliance
- Asbestos

- Polychlorinated biphenyls (PCBs)
- Radon hazards
- Lead-based paints and plumbing
- Underground storage tanks (USTs)
- Current or potential restraints on facility utilization
- Environmental issues requiring resolution
- Other environmental concerns that might present impediments to the transfer and/or release of Federally owned property.

## 1.2 OBJECTIVES

This enhanced PA is based on existing information provided by the facility and various other agencies regarding environmental setting, facilities, operations, initial property acquisition, initial construction, and major renovations and remodeling performed by local contractors or by the U.S. Army Corps of Engineers (USACE). The PA effort does not include the generation of new data. The objectives of the PA include:

- Identifying and characterizing all areas requiring environmental evaluation (AREEs)
- Identifying AREEs that may require a site investigation
- Identifying AREEs that may require immediate remedial action
- Identifying other actions that may be necessary to address and resolve all identified environmental problems
- Identifying other environmental concerns that may present impediments to the expeditious transfer of this property
- Identifying property areas which require no additional investigation.

## 1.3 PROCEDURES

The PA began with a review of Army records and an overview visit at NADA, Bellemont, Arizona (AZ), on October 26, 1989. An extended visit was conducted at NADA during the week of November 27 - December 1, 1989, at which time additional information was obtained through personal observations of EBASCO investigators (EBASCO 1989a; EBASCO, 1989b). Interviews with NADA and off-site agencies personnel were also conducted during this visit. Photographs were taken at AREEs and surrounding properties as a means of documenting the

present condition of the installation and immediate land uses. The captioned photographs are included as Appendix B.

NADA is an extensive facility with several varied current and historical missions. The Command Structure at NADA was reviewed to supplement the examination of those activities and sites at the installation with the potential for environmental impact. A description of the NADA mission and command structure is included in Section 2.1.2.

Relevant information from NADA records and files was obtained from the NADA Environmental Coordinator and other personnel during both the reconnaissance trip and the site visit. Additional relevant information and aerial photographs of NADA were provided by USATHAMA. Supplemental information regarding the environmental characteristics of the area was obtained from the U.S. Geological Survey (USGS) office in Flagstaff, AZ, the USGS Library in Denver, Colorado, and the Arizona Department of Water Resources (ADWR) in Phoenix, AZ. Finally, information on potential hazardous waste disposal sites in the area was provided by the Arizona Department of Environmental Quality (ADEQ), Phoenix, AZ.

#### 1.4 PA REPORT OUTLINE

Section 2.0 of this preliminary assessment report provides a general description of the environmental setting and facilities studied. Not all NADA facilities or activities are addressed in this assessment. Rather, only those facilities that may have affected the environment are addressed here. Potential for affecting the environment is determined by the nature of activities conducted at each facility, the amounts and types of materials present at the facility, and the nature of the wastes routinely produced at the facility. The evolution of NADA as a military depot has been routinely documented, and a brief history of NADA is provided. Relatively modest documentation exists from the perspectives of environmental setting, resources, and impact.

There have been two general environmental assessments of NADA, one conducted under the auspices of the USATHAMA Installation Restoration Program: the 1979 Installation Assessment of NADA (USATHAMA, 1979), and the other under the auspices of U.S. Army Depot System Command (DESCOM): the 1982 Installation Environmental Assessment (Inland Pacific, 1982). There have also been a number of more site-specific environmental studies and evaluations that served to document environmental impacts from various NADA facilities and from certain events. These studies are identified and referenced in Section 2.5. Section 2.0 provides a brief description of the environmental features of NADA and its demographic, physical, and cultural settings. Also summarized are various Army inter-agency communications and those between NADA and local environmental regulatory officials relating to environmental issues and releases associated with NADA.

Section 3.0 characterizes all identified AREEs, both past and current, that are associated with NADA. Included in this section are discussions of all facility operations that generate wastes of concern. Also identified are all occurrences of hazardous materials storage at NADA and spills of such materials that have occurred in the past. Current waste-management procedures are discussed.

Sections 4.0, 5.0, and 6.0 discuss the chief environmental facts and judgments of this assessment. Section 4.0 discusses all known or suspected releases to the environment from NADA activities. Section 5.0 provides conclusions regarding current environmental impacts and discusses the potential for future impacts to the environment. Section 6.0 provides recommendations for resolving all major outstanding environmental issues associated with NADA, identifies actions that will eliminate or reduce the potential for future environmental releases, and identifies additional environmental studies that are warranted or necessary for complete characterizations of known or suspected environmental impacts.

## **2.0 PROPERTY CHARACTERIZATION**

### **2.1 GENERAL PROPERTY INFORMATION**

#### **2.1.1 Property Location and Identification**

The Navajo Depot Activity occupies 28,347 acres (11,472 hectares (ha)) of land in north-central Arizona. The activity is in rural Coconino County, approximately 12 miles west of the city of Flagstaff. Interstate Route 40 and the Atchison, Topeka, and Santa Fe Railroad parallel the northern boundary and provide transportation access to this fenced facility. Some private and commercial land is found along this northern boundary. Land to the east, south, and west is primarily national forest or is owned by the State of Arizona. Figure 2-1 is a location map for NADA.

#### **2.1.2 Current Mission and Status**

NADA is one of four installations assigned as activities under the Tooele Army Depot in Tooele, Utah. Its assigned mission is to operate as a reserve supply depot for the receipt, shipping, storage, surveillance, minor maintenance, and demilitarization of ammunition and assigned commodities. The installation also provides limited maintenance to preclude deterioration of facilities.

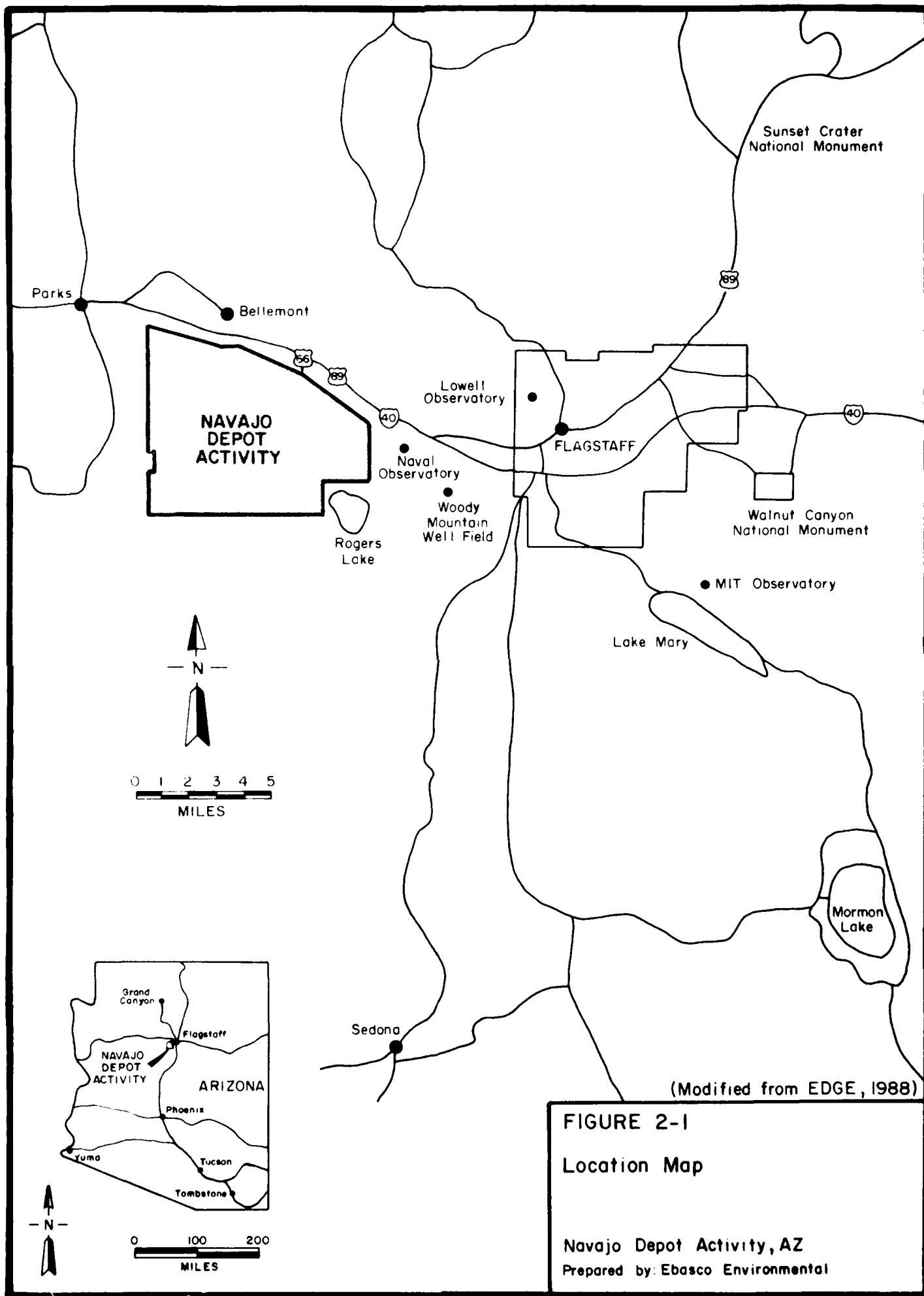
Since June 1982, operational control of NADA has been transferred from the Secretary of the Army to the Arizona National Guard (ANG) under License Number DACA09-3-82-153 (U.S. Army, 1982a). The responsibilities of the National Guard in carrying out the mission of NADA for the Army are spelled out in Interservice Support Agreement (ISSA) Number W6ILP3 (U.S. Army, 1982b). The ISSA superseded former Lease C shown of Figure 2-2. An additional assumed component was appended to the NADA mission with the establishment of the ISSA. The purpose of the 1982 Transfer of Accountability is for NADA to provide training opportunities for Reserve Components. The depot is currently a Category D sized major training area for the ANG. Overall command of the facility is maintained by the Tooele Army Depot, and a technical liaison staff of five Tooele employees is stationed at NADA to fulfill the Army's obligations under the ISSA.

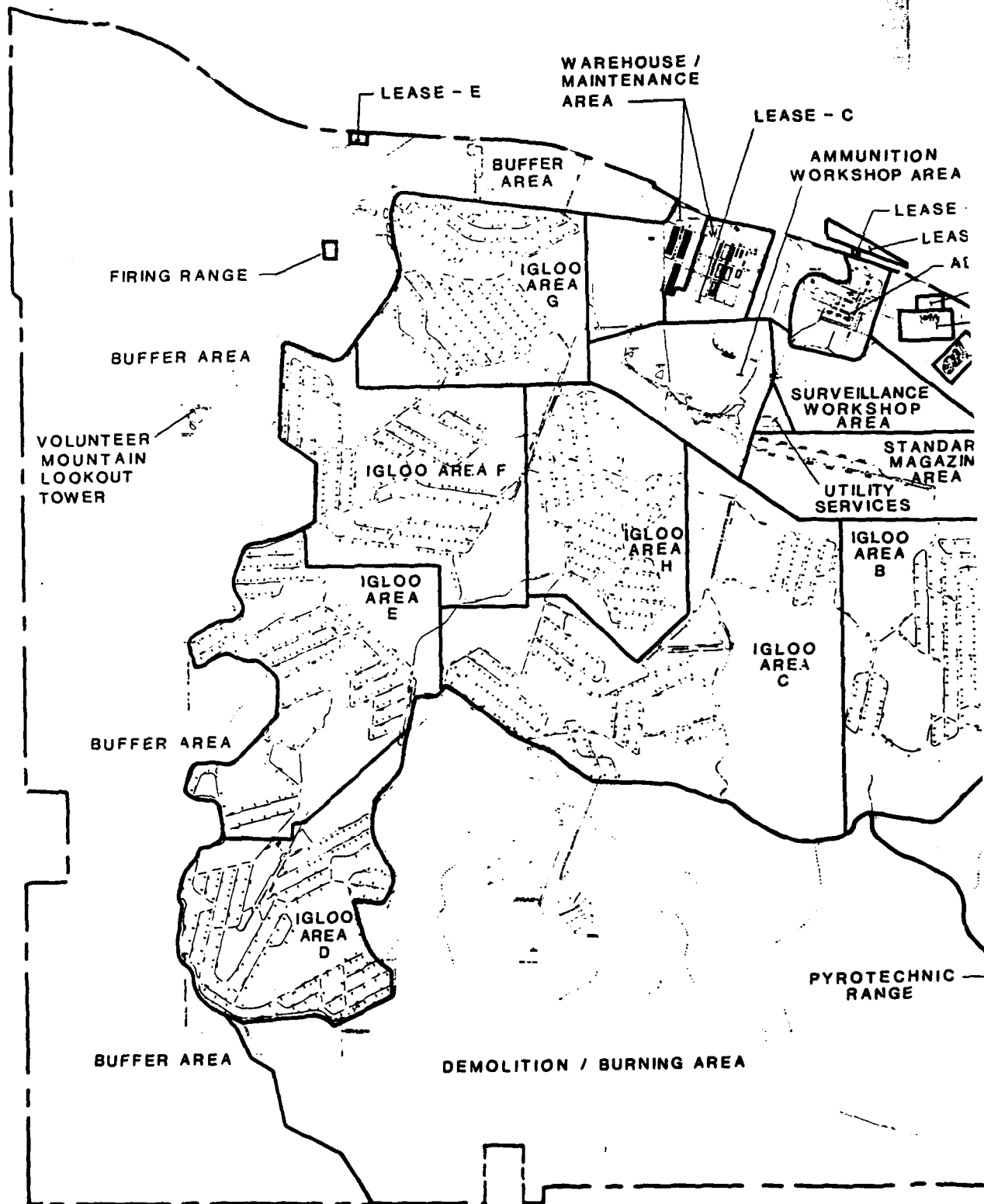
Operation of the installation is the responsibility of the NADA Commander. Under the Office of the Commander, the organization includes three Directorates: the Director for Supply, Ammunition, and Transportation; the Director for Administrations and Services; and the Director for Plans, Operations and Training. About 118 people are employed by the State of Arizona under this organizational structure to operate NADA.

Within the boundaries of NADA there is a 20 acre training facility owned and operated by the ANG. In addition there are several parcels of land leased to tenants. These are discussed in the description of facilities in Section 2.2.

### **2.2 DESCRIPTION OF FACILITIES**

The activities at NADA are generally segregated by area. Figure 2-2 shows the base facilities, land use areas, and parcels of leased land. These will be discussed by area in the following sections.

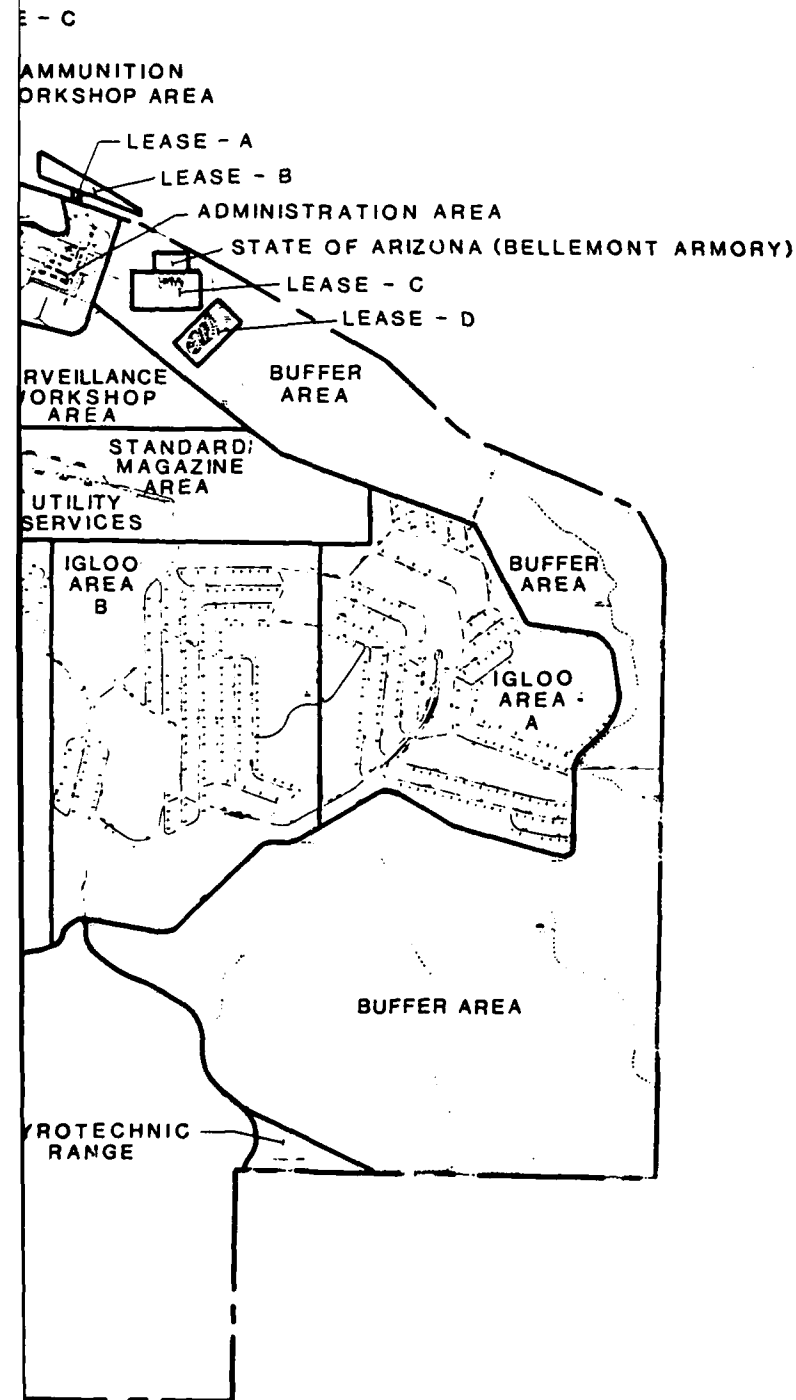




### Legend

- LEASE A - Atchison Topeka & Santa Fe Railroad
- LEASE B - U.S. Department of Interior
- LEASE C - Arizona National Guard (discontinued in 1982)
- LEASE D - Bruskin Agency
- LEASE E - Arizona Department of Transportation

--- Military Reservation Boundary



(Modified from USACE, BIM  
Reservation Site Map, 1987)

### FIGURE 2-2

#### Land Use Map

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

2 of 2

### **2.2.1 Administration Area**

The Administration Area at the entrance in the north-central portion of NADA consists of about 40 structures. In addition to housing administrative offices for NADA, this area also contains maintenance facilities. These include the vehicle maintenance shops and the fuel station, the carpentry, plumbing, and electrical shops, and associated warehouse and storage structures. Other AREEs located in the Administration Area include an unused incinerator and an Open Air Storage Yard where used and discarded materials are stored for eventual recycling or disposal.

### **2.2.2 Warehouse Area**

The Warehouse Area to the west of the Administration Area contains three large warehouses (Buildings 239-241) where stockpiles of strategic materials such as crude rubber and tannin are stored. These were originally General Services Administration (GSA) materials, but now the Defense Logistics Agency (DLA) supervises this storage activity. Pesticide storage for the base is in Building 244 north of these warehouses. Some of the remaining buildings are used for storage, while others are old warehouses that have become dilapidated to the point of collapse and have no useful purpose. An asphalt plant has been set up by the ANG in this area.

### **2.2.3 Workshop Areas**

The Workshop Area immediately south of the Warehouse and Administration Areas includes the Ammunition Workshop Area and the Surveillance Workshop Area. The Ammunition Workshops were used for renovation and demilitarization of munitions. These operations included propellant debagging, primer removal, shell disassembly, paint removal, painting, and trinitrotoluene (TNT) removal and recovery. A deactivation furnace was also used to deactivate small arms ammunition, tracers, primers, detonators, delays, and fuzes (USATHAMA, 1979). Most of these operations have now ceased. Building 301, Ammunition Workshop, and Building 310, the less than truckload facility, are the only currently active facilities in the Ammunition Workshop Area.

The Surveillance Workshop was formerly used for surveillance of controlled quantities of propellants, explosives, fuzes, and primers under controlled climatic conditions (USATHAMA, 1979). This facility is currently used for munitions inspection activities.

The Sewage Treatment Plant (STP) is located in the Utility Services Area between the workshops.

### **2.2.4 Igloo and Standard Magazine Areas**

Igloo Areas A through H comprise a large portion of the central area of NADA and provide extensive munitions storage capacity. These igloos are of reinforced-concrete construction and were designed to minimize the effects of a blast. Of the 776 igloos, 340 are currently used for the storage of conventional ordnance and pyrotechnic materials (EBASCO, 1989b). Igloos in the D Area were at one time used to store chemical agent filled bombs. Other materials including mercury, pesticides, and tritium have also been stored in igloos at NADA.

The Standard Magazine Area east of the Ammunition Workshop Area and north of the Igloo Areas is used as a transfer point for moving munitions in and out of the Igloo Areas. Commercial trucks load and unload materials at the standard magazines. Military vehicles shuttle materials between the standard magazines and the igloos. Usage of the 12 standard magazines fluctuates; at times, all 12 are utilized (EBASCO, 1989b).

The Former Sanitary Landfill for NADA is located in the eastern side of the Standard Magazine Area. This landfill has not been used since 1966.

#### 2.2.5 Demolition Area and Pyrotechnic Range

The Demolition Area is used to demilitarize conventional munitions that have become obsolete or unserviceable. The vicinity in which demolition operations are conducted has been divided into two primary usage areas. The following descriptions have been taken largely from the RCRA Part B Permit Application, NADA Open Burning/Open Detonation Areas (OB/OD) (EDGE, 1988).

The OD area is used for open detonation of explosives and pyrotechnics. Open detonation takes place in flat bulldozed pits with a dirt berm. A maximum of 10 to 14 pits are operational on a given day. Limits on aboveground and below ground demolition are 5,000 pounds and 10,000 pounds net explosive weight, respectively. The maximum actually detonated at any one time at NADA has been 1,200 pounds.

The OB area is reserved for the open burning of dunnage, shipping boxes, and empty explosive containers. Burning is conducted in four burn pans with a bulk dry propellant as fuel. The maximum burn rate is currently once per day.

Historical operations in the demolition area have included the burning of white phosphorus (WP) and plasticized white phosphorus (PWP) ammunition, detonation and burning of several mustard (H)-filled bombs, venting of phosgene (CG)-and cyanogen chloride (CK)-filled bombs, and demolition of napalm-filled firebombs. Pallets that were contaminated with mercury as the result of a leaking storage cylinder were burned in this area. TNT-contaminated wastewater and sulfuric, hydrochloric, and chromic acids were also disposed here (USATHAMA, 1979).

The adjacent Pyrotechnic Range was used for the surveillance testing of grenades, rocket motors, and small-arms ammunition. High explosive (HE), hexachloroethane (HC), colored smoke, WP, PWP, tearing agent (CN), riot control agent (CS), and thermite were contained in some of the items tested (USATHAMA, 1979). This area is no longer used for surveillance testing.

#### 2.2.6 Buffer Areas

The buffer areas on the Depot's perimeter are used for training exercises and bivouacs by National Guard troops. Small arms blank ammunition and hand grenades containing colored smoke, HC, CN, and CS are used during these training exercises. No latrines are dug in the Buffer Area, and the area is policed upon completion of exercises (USATHAMA, 1979).

The buffer areas have been developed with map and compass courses, bivouac areas, a firing range, a mock Ammunition Supply Point, and a road network.

The Firing Range for rifles and pistols has been constructed in the northwest buffer area. The National Guard, the NADA Security Police, and the Arizona Highway Patrol use this facility for qualification and weapon proficiency firing.

North of the Firing Range is the location of the former Indian Village where workers were housed from the time of construction of NADA until 1971. The water tank for the former Indian Village is now leased to the Arizona Department of Transportation (Lease E) as a water supply for a rest stop along Interstate 40 (Figure 2-2). Imhoff tanks from the former Indian Village are in this vicinity.

The Bellemont Armory to the east of the Administration Area is a 20 acre site owned by the State of Arizona (Figure 2-2). The Arizona National Guard operates a vehicle maintenance facility here. South of the Armory is the former base hospital site. It is now used by the State of Arizona as quarters for National Guard troops during training activities.

Lease D, to the southeast of the Armory, contains a complex of 69 units of Wherry Housing leased by the Bruskin Agency of New Jersey. These units are rented to private individuals including some installation employees.

Areas A and B to the north of NADA are leased by the Atchison, Topeka, and Santa Fe Railroad and the Department of Interior, respectively. There are no facilities on these parcels.

### 2.3 PROPERTY HISTORY

The history of the property prior to establishment of NADA is not well documented in base records. Activities in the area included homesteading, ranching, and logging. The following history of NADA is taken largely from the Installation Environmental Assessment (Inland Pacific, 1982).

The Navajo Depot was established by the purchase of privately owned land and the transfer of forest lands from the Kaibab and Coconino National Forests. Activation of the Navajo Ordnance Depot took place on July 1, 1942. The first carload of ammunition was received on November 6, 1942, and the first shipment from the Depot was made on November 11, 1942. Construction was completed in January 1943. Severe weather in the area, rocky terrain, and the installation's remote location all hindered initial construction. The Navajo Indian Reservation was the major source of unskilled labor during construction. This labor force was accommodated by housing in the form of an "Indian Village," which was constructed in 1942 and finally deactivated in 1971. The Navajo Ordnance Depot became a backup facility for the Erie Ordnance Depot and later the Benicia California Arsenal. Peak employment of 2,173 persons occurred in 1945.

From early 1945 to the end of World War II, the Navajo Depot Activity served as a prisoner-of-war camp for Austrian soldiers. The initial shipment of chemical warfare service ammunition arrived at NADA in January 1945. The shipment consisted of CG, CK and

mustard (H)-filled bombs. On April 16, 1949, a conventional munitions igloo (G-147) exploded, but no injuries occurred.

The initial construction of the Ammunition Workshop was completed in the 1940s. The original complex consisted of seven buildings and support facilities for renovation, demilitarization, and normal maintenance. Other buildings and facilities continued to be added into the mid to late 1950s. The TNT washout unit in the Ammunition Workshop Area was converted to a closed system in January 1953, thus reducing "pink water" waste generation. In 1953, three fire-resistant warehouses were built by GSA to accommodate the newly assigned mission of GSA material receipt, storage, and issue. In 1958 the entire NADA stockpile of mustard munitions was removed in a 24 car rail shipment. The stockpile was disposed via sea-dump. The installation of a deactivation furnace was completed on April 24, 1961.

NADA was assigned a Defense Supply Agency Depot mission on February 13, 1967. At the same time the installation was assigned a mission of storing Air Force fire bombs and related fuzing components. On March 1, 1971, the Navajo Army Depot was placed under reserve status and redesignated as Navajo Depot Activity under the command of the Pueblo Army Depot. In 1975 the installation was reassigned to the command of the Tooele Army Depot. In June 1982, operational control of NADA was transferred to the ANG under license from the Secretary of the Army (U.S. Army, 1982a).

## 2.4 ENVIRONMENTAL SETTING AND SURROUNDING LAND USE

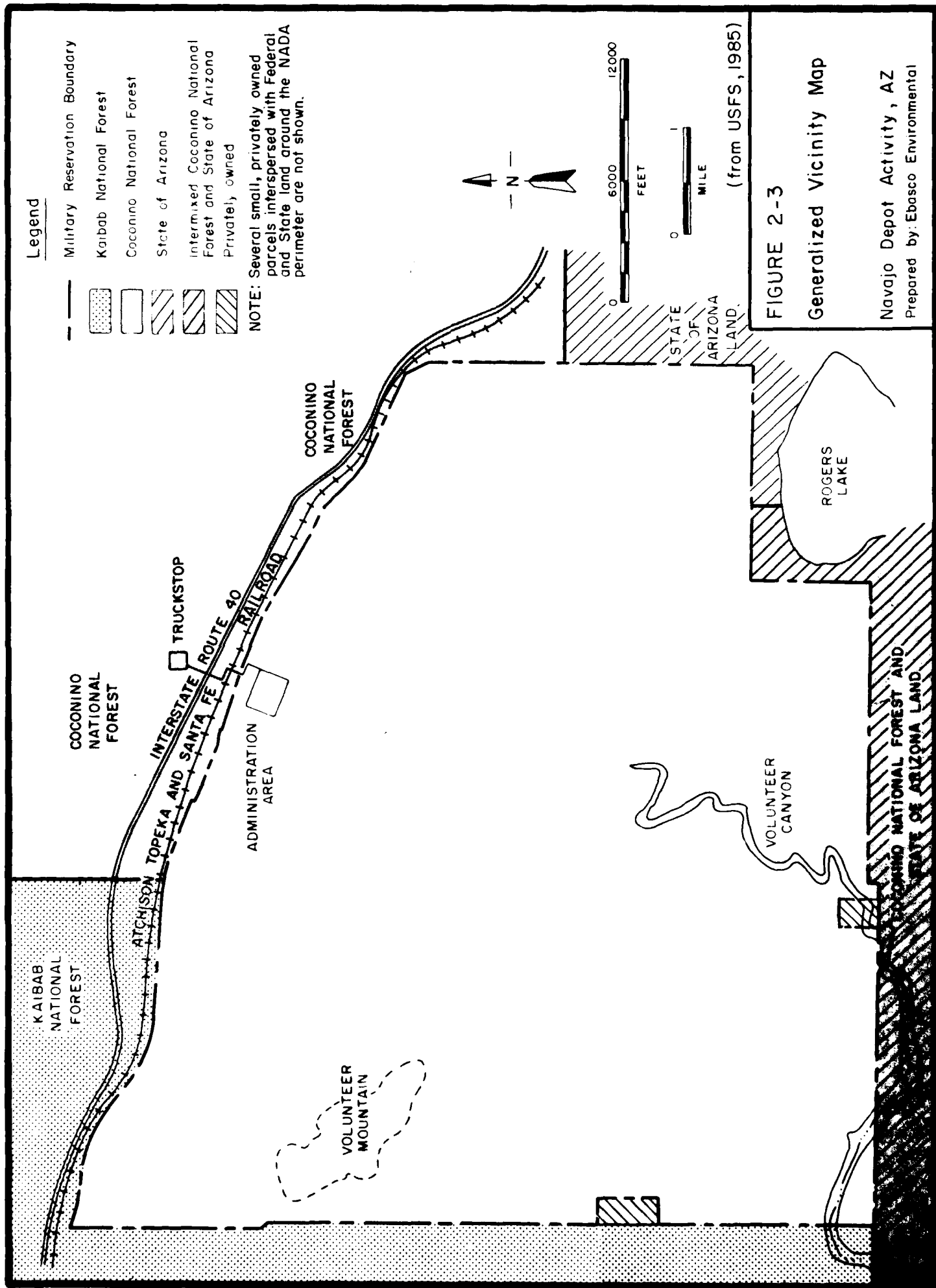
### 2.4.1 Demographic Factors and Regional Land Use

#### 2.4.1.1 Local Setting

NADA is situated in a small topographic basin in south-central Coconino County, approximately 12 miles west of Flagstaff, the county seat (Figure 2-1). The City of Williams is located approximately 17 miles west of NADA. The western portion of NADA is partially encompassed by the Kaibab National Forest, and the eastern portion adjoins a part of the Coconino National Forest and State of Arizona land (Figure 2-3). The area has varied relief including mountain peaks, flat valleys, and steeply walled canyons. The lands surrounding the Depot are predominantly multiple use under national forest designation, with scattered parcels under state and private ownership (EDGE, 1988).

Interstate 40 and the Santa Fe Railroad corridors run along the northern boundary of the Depot. Both are major regional and national transportation routes. A truck stop is located on the north side of the I-40 Depot interchange. There are also some mobile homes located around the truck stop. Between I-40 and the Santa Fe line west of the main gate at the former site of Bellemont, Arizona, are located several older structures, which include three occupied residences. The Bellemont railroad station was formerly located in this area. A pit for cinder excavation (and crushing) is located between I-40 and the northwest corner of the Depot. The area north of I-40 consists of multiple use national forest lands (Coconino and Kaibab National Forests), which are used for grazing, timber, and recreation (EDGE, 1988).

The Parks rest area along I-40 is northwest of NADA and acquires water from a water tower formerly affiliated with the NADA Indian Villages. NADA supplies this water tower from the Depot water supply system.



The lands east of the Depot are predominantly undeveloped and under either state or U.S. Forest Service (USFS) administration. The land is forested and also used for grazing. Rogers Lake is located adjacent to the southeast corner of the Depot. Some scattered homes are located on privately owned parcels along the lake shore.

South of the Depot are primarily national forest lands (Coconino National Forest) with some state and minor private ownership. This area is undeveloped forest land and used for grazing, timber, and recreation.

West of the Depot are predominantly national forest lands (Kaibab National Forest) with scattered parcels of private ownership. The terrain is mountainous and forested immediately adjacent to the western Depot boundary and levels to Garland Prairie further west. Garland Prairie is an open area that contains numerous scattered residences on privately owned parcels (generally 10 acres or more).

Policy and regulatory guidelines for the lands surrounding the Depot are administered by the USFS, the State of Arizona, or Coconino County. Most of the lands surrounding the Depot are under the administration of the USFS. The lands will remain undeveloped multiple use including recreation, timbering, or grazing. Generally, the same constraints on development apply to state trust lands in the area.

The administration of land use and zoning guidelines on privately owned land is under the jurisdiction of Coconino County (except for lands within incorporated areas). The county has a comprehensive plan and is in the process of updating it. It should be pointed out that the proposed land use map for the revised plan designates the area north of the Depot as light urban (1,000 people per square mile) and the area east of the Depot as heavy urban (2,500 people per square mile). This would apply to privately owned lands but not to national forest or state trust lands (EDGE, 1988).

The lands surrounding the Depot are zoned either General (G) or Open Space and Conservation (OS), with the exception of a parcel between I-40 and the Depot, which is zoned Commercial Heavy (CH). Privately owned lands are zoned G and publicly owned lands are zoned OS. The parcel zoned CH is located between I-40 and the frontage road south of the interchange.

The G zone is a general rural land use category intended for application to those unincorporated areas of the county not specifically designated in any other zone classification. Only those uses are permitted that are complementary to and compatible with a rural environment. The G zone allows a variety of uses including single-family dwellings, agricultural uses, and various public and semipublic uses. The minimum lot size for buildings is 10 acres.

The OS zone is intended primarily for those areas of the county where it is desirable and necessary to provide permanent open spaces when such are necessary to safeguard the health, safety, and general welfare, and to provide for the location and preservation of scenic areas

and recreation areas. This zone classification is intended to be applied primarily to lands held under public ownership.

The CH zone is intended to provide appropriately located areas for establishments catering primarily to highway travelers, visitors to the county, or such businesses or uses where direct access to major arterial highways is essential or desirable for their operation. The minimum building site in a CH zone is 10,000 square feet (ft).

Population growth in Arizona amounted to approximately 53 percent over the last 10 years. This compares with a 36.4 percent increase in population experienced in the 1960s. The major areas of recent population growth within the state have been Phoenix in Maricopa County and Tucson in Pima County. Apache, Coconino, Mohave, Yavapai, and Yuma counties also experienced significant growth rates during this period, though they had a much smaller population base to begin with.

Coconino County grew by approximately 55 percent over the last 10 years, to approximately 93,000. This growth rate was significantly greater than the 15.5 percent increase in population experienced during the 1960s. The City of Flagstaff population accounts for 46.3 percent of the county's total population.

Projections of future population growth in Coconino County are shown in Table 2-1. Coconino County is expected to experience a somewhat higher growth rate than either the state as a whole or the City of Flagstaff through the year 2000. The projected growth rate for the City of Flagstaff is slightly less than, but fairly close to, the rate projected for the state as a whole.

Table 2-1  
Population Projections for Arizona and Coconino County

	<u>1990</u>	<u>1995</u>	<u>2000</u>
State of Arizona	3,618,000	4,038,000	4,565,900
Percent Change	12.7	11.6	13.1
Coconino County	107,300	122,300	139,300
Percent Change	15.9	14.0	13.9
City of Flagstaff	45,975	51,185	57,100
Percent Change	12.5	11.3	11.16

Source: U.S. Department of Commerce, Bureau of Census, 1980 census of population and housing; and Arizona Department of Economic Security, Population Statistics Unit (from EDGE, 1988).

#### 2.4.1.2 Potential Environmental Impacts in the Vicinity of NADA

The potential for environmental problems in the NADA vicinity is low due to the sparsely populated area and generally undeveloped setting. However, several known or potential environmental problems should be mentioned in order to properly characterize the NADA environmental setting. Sewage lagoons affiliated with the truckstop north of the I-40 interchange have overflowed historically. It was not uncommon during the spring thaw for raw effluent to flow down the drainage south under the highway onto the Depot. This drainage is part of the upper tributaries of Volunteer Canyon and holds Reservoir 1. This overflow and runoff caused coliform contamination of Reservoir 1, which can serve as a backup water supply to Springs 1 and 2, the primary NADA drinking water sources (USATHAMA, 1979; EBASCO, 1989b). The truckstop is also considered hydrogeologically upgradient of NADA, with respect to the shallow perched water tables contained in the alluvium and volcanic rocks north of NADA. However, no hydrogeologic studies have been conducted to document flow directions and velocities (Graf, 1989). Any spills or seepage from the sewage lagoons or USTs would likely travel toward the south upon entry in the shallow perched groundwater flow system.

Other neighboring land use with a potential for upgradient impacts include the Santa Fe Railroad, the ANG Bellemont Armory, and a motorcycle dealership along the abandoned Route 66 roadway between I-40 and the railroad east of the NADA entrance. No recent spills or incidents are documented along the Santa Fe Railroad. No knowledge of historical spills could be found (EBASCO, 1989b). The newly constructed ANG Bellemont Armory, which houses vehicle maintenance facilities, has had no reported spills or contamination (EBASCO, 1989b). The motorcycle dealership located roughly north of the NADA Wherry Housing area was observed during a drive-by windshield survey to have several unlabeled 55 gallon drums lying in a fenced area to the west of its main building. A variety of junk and debris was also observed in the vicinity of the building. It is not known if any USTs are present at the dealership nor if any spillage of wastes has occurred from the stacked drums (EBASCO, 1989b). The presence of any USTs is not known in the old Bellemont townsite or at any of the abandoned former motel sites along the abandoned Route 66 right-of-way, all potentially hydrogeologically upgradient in the shallow perched groundwater at NADA (EBASCO, 1989b).

The City of Flagstaff has recently shown concern for potential contamination of the regional Coconino-Supai aquifer and has commissioned a literature research study. This study was submitted to the ADEQ for funding under provisions of the Arizona Water Quality Assurance Revolving Fund (WQARF) and was intended to assess the potential for groundwater contamination that might be threatening its Woody Mountain Well Field, located approximately 5 miles southeast of the eastern boundary of NADA (HDR, 1989). The report inferred that past waste management practices at NADA and the W.L. Gore Woody Mountain Facility, a private research facility located 2 miles north of the Woody Mountain Well Field and approximately 5 miles northeast of NADA, could pose threats to the Woody Mountain Well Field, even though no contaminants have been detected in the water from the well field and contaminants have repeatedly not been detected above allowable levels in the NADA deep well. The NADA deep well is completed in the Coconino-Supai aquifer as is the Woody Mountain Well Field. Also, regional hydrogeologic information, although scanty, does not conclusively indicate that NADA or W.L. Gore is upgradient of the well field. The report of

the study contains recommendations for future monitoring studies at Woody Mountain Well Field (HDR, 1989) and is presently out for public review and comment.

#### 2.4.2 Climate and Air Quality

The semiarid climate of the Flagstaff area, including NADA, is characterized by cold winters, mild summers, and a considerable diurnal temperature change. The average daily temperatures are seasonally low as compared with other parts of Arizona and the nation. As a result, the growing season is only about 120 days. Climatological data for the Flagstaff area is presented in Table 2-2. The topographic setting of the facility is similar to the Flagstaff area only 11 miles to the east, and, consequently, climatological data from Flagstaff should be fairly representative of NADA conditions.

Since NADA is in a mountainous area, as opposed to the desert that characterizes most of the rest of the state, temperatures tend to be moderate, with low temperatures quite common in the winter. The area is moderately dry in terms of both relative humidity and precipitation. The majority of the days are clear or partly cloudy. The high proportion of clear nights, coupled with good air quality and low levels of light pollution, has led to the establishment of two major and two small astronomical observatories in the Flagstaff area (Coconino County, 1989).

There is a large diurnal temperature variation in the Flagstaff area. The average daily maximum is 60°F; the average daily minimum is 30°F. The prevailing wind direction is south-by-southwest, with an average speed of 7.4 miles per hour. Figure 2-4 displays the annual wind rose diagram for the Flagstaff area.

The months of greatest precipitation are July, August, and December. The average yearly rainfall is 20 inches, and the average annual snowfall is 82 inches.

When the heavy accumulation of snow melts in the mountains, occasional flooding of lowland areas results. Due to the dry climate, evaporation is significant, accounting for water losses of 60 inches per year from exposed storage (EDGE, 1988).

Because of the consistently good ventilation experienced in the area, discharged air pollutants are readily dispersed. This is reflected in the low level of pollutant concentrations that have been recorded in the vicinity for several years as described below.

The EPA has established standards for a number of air pollutants. The State of Arizona has adopted these Federal standards. Primary standards are designed to protect the public health by providing an adequate safety margin in pollution levels. Secondary levels are established to provide for the public welfare, which is a broad concept covering effects on soil, water, vegetation, animals, weather, visibility, and personal comfort and well being.

In 1974, as a part of its Prevention of Significant Deterioration (PSD) Program, EPA established three air quality classifications for areas where ambient air quality standards are being met, based on the incremental increase permitted in ambient concentrations of particulate matter and sulfur dioxide (SO<sub>2</sub>). These classifications are defined in Table 2-3. The NADA

Table 2-2  
Climatological Data for NADA

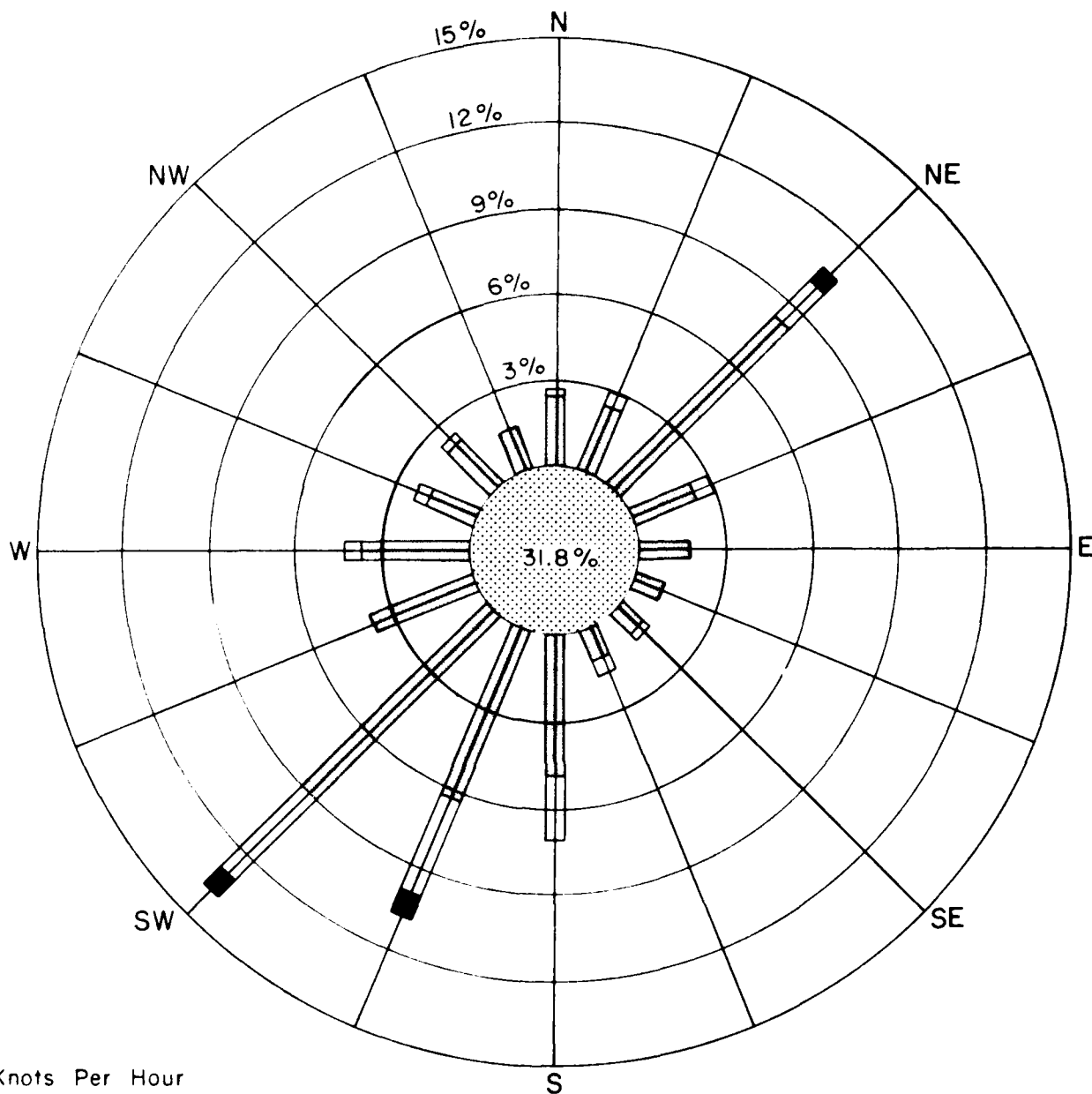
Month	Temperature <sup>1</sup>		Precip. <sup>1</sup> Mean (in)	Snow <sup>2</sup> Total (in)	RH <sup>2</sup> Mean (%)	Sunshine <sup>1</sup> (%)	Sky Cover <sup>1</sup> (tenths)	Mean No. of Days <sup>1</sup>		
	Maximum	Minimum (°F)						Clear	Partly Cloudy	Cloudy
Jan.	41.4	14.4	27.9	1.89	52	75	5.3	13	6	12
Feb.	44.0	17.0	30.5	1.47	51	72	5.0	12	5	11
Mar.	47.9	20.4	34.2	1.83	42	69	5.1	12	8	11
Apr.	56.9	27.3	42.1	1.33	35	84	4.5	13	9	8
May	66.6	33.5	50.1	0.56	28	89	3.9	16	9	6
June	76.0	40.4	58.2	0.57	23	90	2.9	19	7	4
July	80.8	50.4	65.6	2.48	34	75	5.4	9	13	9
Aug.	77.9	40.3	64.6	2.65	40	81	5.1	10	13	8
Sept.	73.7	41.2	57.5	1.68	37	82	3.5	17	8	5
Oct.	62.9	31.1	47.0	1.37	38	78	3.4	18	6	7
Nov.	50.9	21.8	36.4	1.33	44	77	4.0	16	6	8
Dec.	43.2	16.3	29.8	2.15	51	78	4.6	14	7	10
Annual	60.2	30.3	45.3	19.31	39.5	81	4.4	169	97	99

Mean Annual Pan Evaporation (in.)<sup>3</sup> 85  
Mean Annual Lake Evaporation (in.)<sup>3</sup> 60

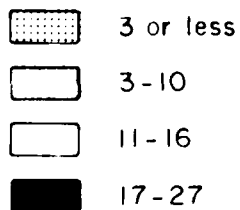
Source: EDGE, 1988; Inland Pacific, 1982

#### REFERENCES:

- <sup>1</sup> Climate of Arizona Climatology of the United States No. 60. National Oceanic and Atmospheric Administration, June 1982.
- <sup>2</sup> Pulliam Airport Station, Flagstaff, AZ (Inland Pacific, 1982).
- <sup>3</sup> Climatic Atlas of the United States. U.S. Department of Commerce, 1983.



Knots Per Hour



Installation

Navajo Depot Activity, AZ.

Location of Data

Flagstaff Municipal Airport, AZ.

Source

After EDGE, 1988

FIGURE 2-4

Annual Wind Rose

Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental

Table 2-3  
EPA Prevention of Significant Deterioration Classifications

<u>Classification</u>	<u>Designation</u>
I	Regions where almost any air quality deterioration would be significant.
II	Regions where deterioration would not be considered significant from moderate, well planned growth.
III	Regions where intensive major industrial growth is desired.

Source: Inland Pacific, 1982

site and immediate surrounding area have been designated attainment areas and categorized a Class II region.

Air quality in the immediate vicinity of NADA has always been good according to the two air quality monitoring sites on the installation. No major problems associated with odors have been noted in the area surrounding the Navajo Depot Activity. There are no land uses in the national forests surrounding the installation that generate odors (Inland Pacific, 1982).

ADEQ operates several air quality monitoring stations in Flagstaff. The only pollutants presently measured in Flagstaff are carbon monoxide (CO), particulate matter with diameters of 10 microns or less (PM-10), and total suspended particulates (TSP). Both TSP and PM-10 samples are also analyzed for sulfate. Table 2-4 summarizes the Flagstaff air quality data for 1986, the most recent year for which the state has compiled this type of information.

As shown in Table 2-4, maximum CO levels at Flagstaff are well within the Arizona and Federal standards for this pollutant. This has apparently been the case for a number of years; the Installation Environmental Assessment (Inland Pacific, 1982) for NADA stated that CO levels during the years 1976 to 1980 were also in compliance with applicable standards. The 1986 annual data report published by ADEQ shows a steady decrease in 8 hour CO levels from 1980 to 1986.

Only one of the three state TSP stations operating in 1986 showed exceedances of the annual and 24 hour standards for this pollutant. Levels at the Dodge Avenue station reached 842 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) (24 hour average) and 172  $\mu\text{g}/\text{m}^3$  (annual geometric mean). The primary and secondary 24 hour standards were exceeded 19 and 33 times, respectively, based on 53 samples collected during the year. Samples from the TSP stations at Cherry and Agassiz Streets and Cherry and Fourth Streets and samples from the PM-10 station at Cherry and Agassiz Streets showed compliance with standards. Note that the Federal TSP standards were abolished in favor of PM-10 standards in 1987. Sulfate levels from TSP and PM-10 samples were very low at the one location recording data on this pollutant in Flagstaff. Annual average and peak 24 hour average concentrations of sulfate were 3  $\mu\text{g}/\text{m}^3$  and 7  $\mu\text{g}/\text{m}^3$ , respectively.

Table 2-4  
Air Quality Data for NADA<sup>1</sup>

Pollutant	Maximum Concentration	State Standard	Federal Standard	<u>No. of Exceedances</u>	
				State Standard	Federal Standard
CO (1-hr) (ppm)	18	35	35	0	0
CO (84-hr) (ppm)	7	9	9	0	0
TSP (24-hr) ( $\mu\text{g}/\text{m}^3$ )	842 <sup>2</sup>	260	260 <sup>3</sup>	19	19
TSP (annual geo. mean) ( $\mu\text{g}/\text{m}^3$ )	172 <sup>2</sup>	75	75 <sup>3</sup>	1	1
PM-10 (24-hr) ( $\mu\text{g}/\text{m}^3$ )	99	-	150	0	0
PM-10 (annual arith. mean) ( $\mu\text{g}/\text{m}^3$ )	38	-	50	-	0

<sup>1</sup> 1986 Air Quality Control for Arizona, Data for Coconino County (Station Flagstaff), Arizona Department of Environmental Quality, August 1987. (EDGE, 1988).

<sup>2</sup> Site terminated or method discontinued.

<sup>3</sup> In 1987, the Federal TSP standard was replaced by the PM-10 standard.

hr - hour

ppm - parts per million

$\mu\text{g}/\text{m}^3$  - micrograms per cubic meter

geo. - geometric

arith. - arithmetic

Ozone and lead are no longer measured in Flagstaff. However, 1980 levels of these pollutants were well below applicable standards (Inland Pacific, 1982). No data on ambient SO<sub>2</sub> concentrations in this geographical area were located; however, the low recorded sulfate levels suggest that SO<sub>2</sub> concentrations are quite low, as well.

#### 2.4.3 Topography

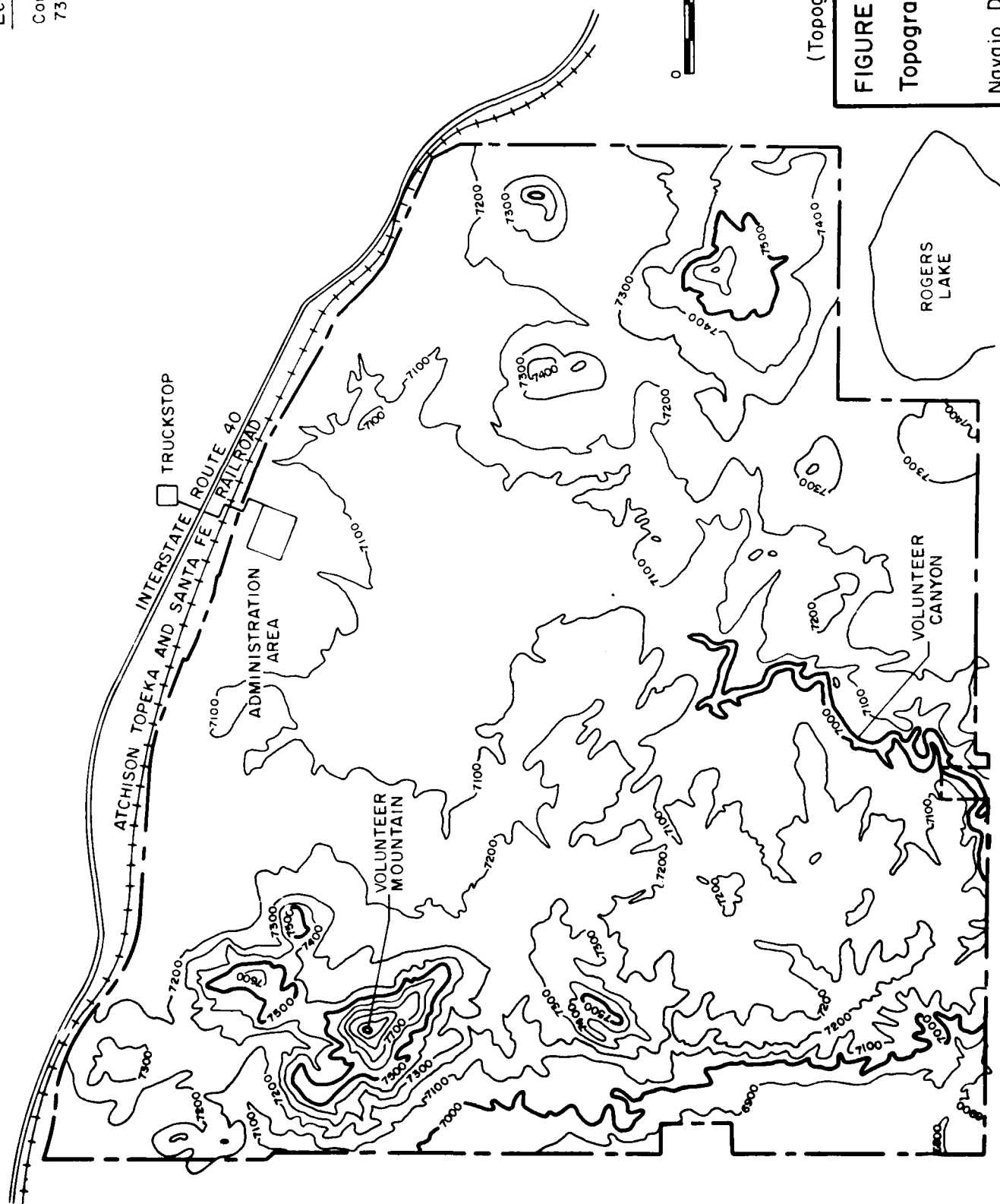
NADA is located within the Grand Canyon Section of the Colorado Plateau physiographic province. The topography of the facility is representative of both the Plateau and the San Francisco volcanic field, of which the volcanic rocks present at NADA are a part. The San Francisco Peaks, located about 15 miles to the northeast, dominate the regional landscape. The Depot and its immediate vicinity are characterized by gentle to rolling terrain, interspersed by canyons, washes, and several volcanic cones (Figure 2-5). The central and northern portions of the site contain rolling, forested hills and flat, grassy prairies, with an average elevation of about 7,100 ft (Appendix B, Photograph 1). Surrounding the central area on the east, south, and west are peaks and ridges of moderate height, averaging 7,500 ft in elevation. The eastern and western perimeter peaks are cinder cones formed during volcanic eruptions, whereas the ridges were produced by basaltic flows. NADA's highest point is 8,047 ft on Volunteer Mountain in the northwest part of the facility and is the location of a forest fire lookout tower. The lowest elevation, 6770 ft, is in the southwest corner of the site where Volunteer Wash crosses the western facility boundary (USATHAMA, 1979).

Drainages at NADA are generally poorly to moderately developed and are dominated by the various tributary subdrainages of Volunteer Canyon. Drainage in the vicinity of the Depot is generally southward along the Volunteer Canyon drainage system toward Sycamore Canyon. In the volcanic terrain, the poorly defined drainage is due to the topography, which results from accretionary geologic processes and the comparatively juvenile erosional form. Volcanic cones and flows on NADA are relatively undissected and their contours reflect volcanic deposition. In the limestone terrain, the poorly to moderately developed drainage is predominantly a function of erosional processes and displays patterns reflecting the structures in the underlying limestone. The limestone also possesses some karst features, which have a tendency to subdue surface drainage expression because of the pirating of surface runoff by features such as sinkholes. The geology of NADA is discussed further in Section 2.4.5, and surface drainages are discussed further in Section 2.4.6.

The topography and terrain have had a strong influence on the land use patterns at NADA. The areas of the site with dense buildings, such as the Administration, Ammunition Workshop, and Warehouse Areas, generally required level, clear terrain. Consequently, they were placed on the broad, flat East and West Prairies in the north-central part of the facility, near the location of potable water in the springs at Reservoirs 1, 2, and 3, and proximal to the Santa Fe Railroad and the highway. However, the roads, railroads and ammunition igloos in the Igloo Areas were positioned and oriented in order to take advantage of the rolling topographic contours in the central portions of the base. The generally more rugged terrain around the NADA perimeter has been used as a training area and buffer zone to the base core facilities.

Legend

Contour Interval is 100 ft.  
7300 - Elevation ft. mean  
sea level



(Topography from USGS, 1963)

**FIGURE 2-5**

**Topographic Map**

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

#### 2.4.4 Soils

The soil properties and distribution have influenced the location of the site facilities. In addition, soil properties affect the migration characteristics and distribution pattern of any potential contaminants residing in the soil and vadose zone. This section briefly summarizes the soil types and distribution at NADA, and was drawn from previous U.S. Department of Agriculture-Soil Conservation Service (SCS) reports included in NADA reference documents and from other previous NADA studies.

Soils on-site are varied in origin, consisting of residual material derived from the *in situ* decomposition of the underlying bedrock and unconsolidated materials. The residual soils, formed from the basaltic and limestone bedrock, are predominantly clays, while soils overlying the alluvium and other unconsolidated materials are varying proportions of sands, silts, and clays (USATHAMA, 1979). Most of the soils were formed from basalt flows and cinders or related volcanic deposits. The exceptions are soils in the central and southern portions of the Depot, which are on limestone formations (SCS, 1970). Previous soil surveys and test borings, taken prior to construction of warehouses and ammunition maintenance facilities, show the soils to be erratically variable in depth; this is a common occurrence in volcanic regions with varying topography and rock types (USATHAMA, 1979).

The General Soil Map, Coconino County, AZ (SCS, 1972), provides the general setting for soil associations in Coconino County, but gives little NADA site-specific information. The Soil Survey of NADA, Coconino County, AZ (SCS, 1970), discusses the physical properties, distribution of soil types at NADA, and suitability for timber and grazing productivity. However, the report does not classify the soils into associations, nor does it denote the percentage of soils that have been disturbed by NADA or pre-NADA activities. Table 2-5 lists 16 different soil units recognized at NADA by the SCS (1970) and the approximate acreage and areal percentage of each. In general, 11 percent of NADA is underlain by deep, clay soils with variable other components on shallow slopes. Fifty-five percent of the soils are moderately deep, clay soils, with variable loam surfaces on moderate slopes, and 32 percent are shallow soils, varying from clay to gravelly loam, on steep slopes. Two percent of NADA is classified as canyon slopes and bottoms.

#### 2.4.5 Geology

This section discusses the surficial and subsurface geology at NADA including the stratigraphic units and geologic structures. The geology at NADA influences surface water hydrology and groundwater hydrogeology, topography, land use, and biota habitat. This discussion is drawn from recent USGS mapping, previous NADA studies, and visual observations. The geology will be discussed from surficial deposits to progressively deeper, and consequently older, units. Subsequently, geologic structures and other features that influence hydrology will be discussed. Figure 2-6 depicts the simplified surface geology at NADA, and Figure 2-7 portrays the stratigraphic column of rocks at NADA down to the water table of the regional aquifer. Figure 2-8 depicts significant geologic features affecting hydrogeology such as faults, volcanic vents, and sinkholes.

Unconsolidated Quaternary alluvium is the youngest geologic unit at NADA and is comprised of alluvial and related deposits. These deposits include silt, sand, gravel, and locally coarser

Table 2-5  
Soil Units  
Approximate Acreage, and Proportionate Extent

Page 1 of 2

Soil Units	Approximate Acreage	Percent of Area
1. Deep clay soils, 0 to 3 percent slopes	310	1
2. Deep clay soils, with a clay loam surface, 0 to 2 percent slopes	900	3
3. Deep clay soils, with a loam surface, 0 to 3 percent slopes	760	3
4. Deep, gravelly clay soils, with a loam surface, 0 to 3 percent slopes	500	2
5. Deep, very gravelly clay soils with a clay loam surface, 1 to 5 percent slopes	460	1
6. Moderately deep clay soils, with a loam surface, 2 to 15 percent slopes	2000	7
7. Moderately deep clay soils, with a gravelly loam surface, 2 to 15 percent slopes	3050	11
8. Moderately deep clay soils, with a very stony loam surface, 0 to 8 percent slopes	7450	26
9. Moderately deep clay soils, with a fine sandy loam surface, 2 to 15 percent slopes	1700	6
10. Moderately deep gravelly clay soils with a loam surface, 0 to 5 percent slopes	1400	5





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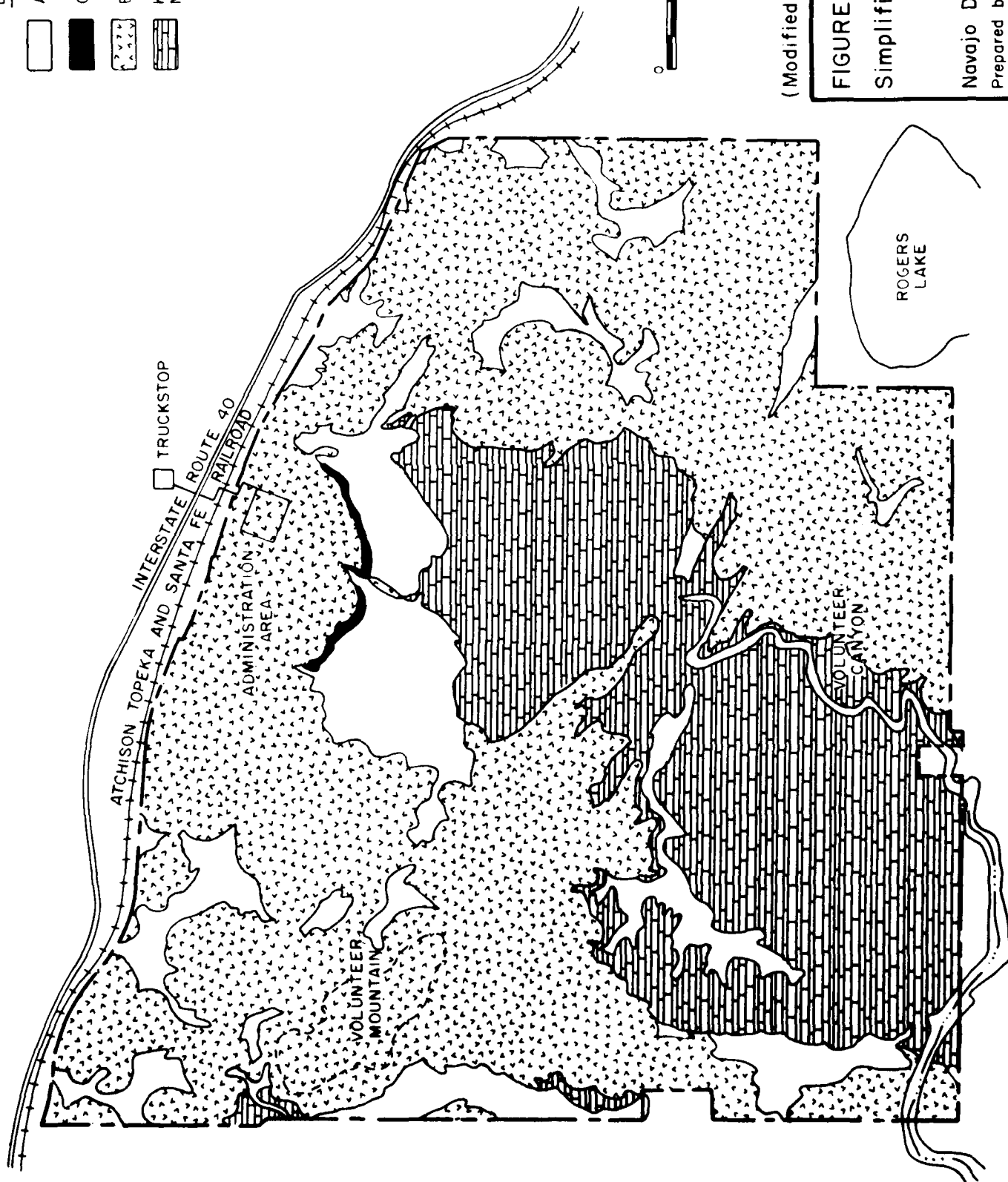
Table 2-5  
Soil Units

Approximate Acreage, and Proportionate Extent		Page 2 of 2	
Soil Units	Approximate Acreage	Percent of Area	
11. Deep clay loam soils, with a gravelly loam surface, 2 to 8 percent slopes	280	1	
12. Shallow clay soils, with a very stony and rocky surface, 2 to 8 percent slopes	305	1	
13. Shallow clay soils, with a very stony and rocky surface, 8 to 30 percent slopes	3385	12	
14. Shallow gravelly loam soils over cinders, 8 to 60 percent slopes	2555	9	
15. Shallow, very stony, gravelly loam soils over limestone, 8 to 30 percent slopes	2730	10	
16. Canyon slopes and bottoms	640	2	

Source: SCS, 1970

Legend

-  Alluvium
-  Clay Bed
-  Basalts
-  Kaibab Limestone and Moenkopi Formation



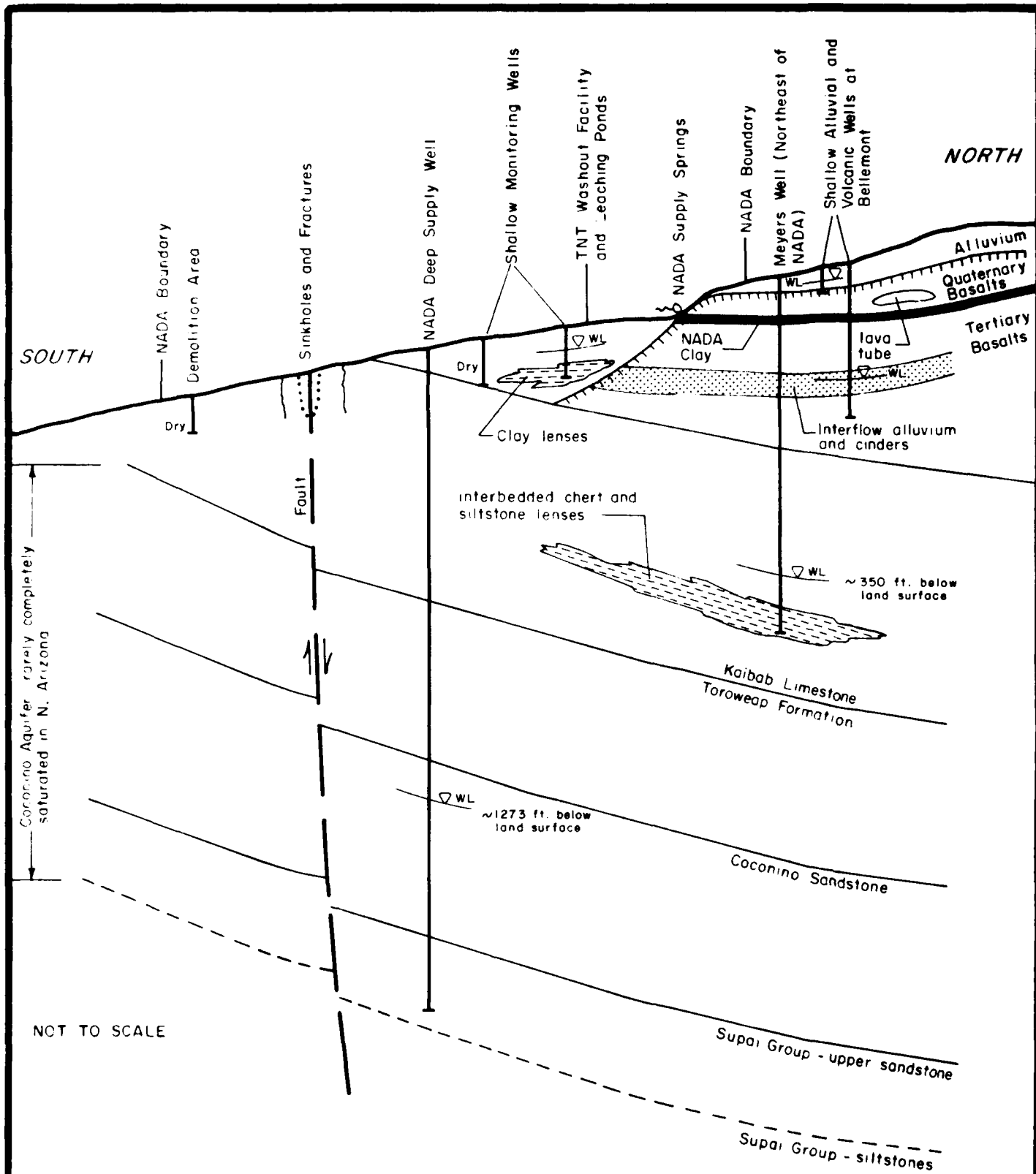
(Modified from Wolfe et al., 1987)

FIGURE 2-6

Simplified Geologic Map

Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental



(Modified after Graf, 1984)

# FIGURE 2-7

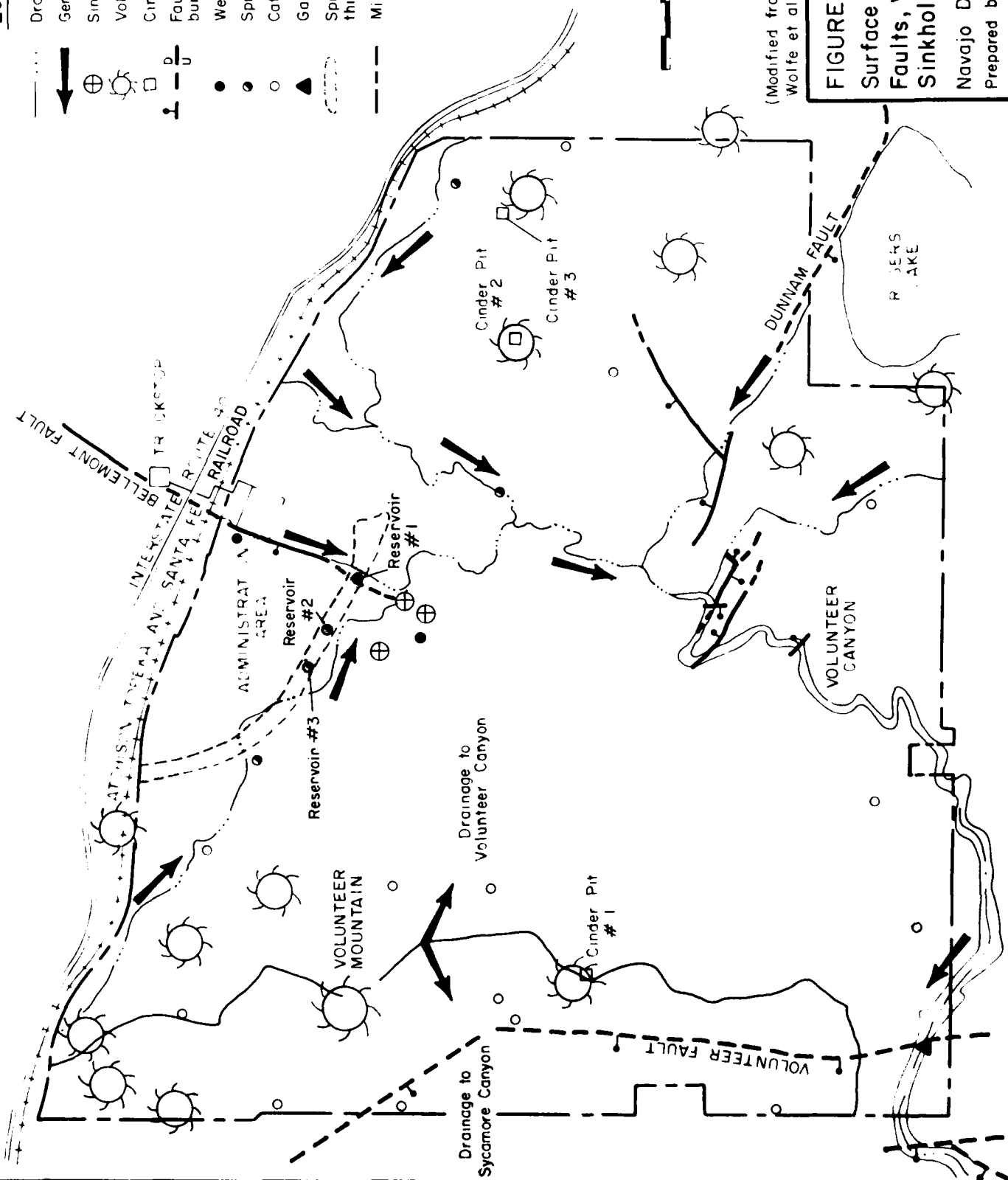
## Schematic Hydrogeologic Representation

Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental

# Legend

- Drainage Ditch
- General Direction of Flow
- Sinkhole
- Volcanic Vent or Cone
- Cinder Pit
- Fault, dashed where inferred or buried
- Well
- Spring Fed Tank or Reservoir
- Catch Basin or Tank
- Gauging Station
- Springs reported prevalent in this area
- Military Reservation Boundary



(Modified from USATHAMA, 1979 and Wolfe et al, 1987)

FIGURE 2-8

Surface Drainage Features,  
Faults, Volcanic Vents, and  
Sinkholes

Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental

materials restricted mostly to drainages and low-lying topographic basins. Deposits were derived from fragments of volcanic materials and Paleozoic sedimentary rocks. Aprons and fans of colluvium and alluvium occur adjacent to the lower flanks of some cinder cones and domes (Wolfe et al., 1987). The unconsolidated deposits in the West Prairie area of NADA contain some clay zones and may have been deposited in a Pleistocene lake impounded by basalt flows, as was regionally typical (ESE, 1981).

Volcanic rocks of Quaternary to Tertiary (Pliocene and Miocene) age comprise the next oldest geologic units and underlie the alluvial deposits. The volcanic rocks that outcrop under approximately two-thirds of NADA in the eastern, northern, and western portions are predominantly basaltic in composition, and range from lava flows to cinder cones. In general, flows predominate away from vent areas, whereas cones at volcanic vents are comprised mostly of cinders, bombs, basaltic tuff, and agglutinated spatter deposits. There are approximately 13 volcanic vents or composite vents recognized within NADA's boundaries, the largest of which is Volunteer Mountain. The volcanic cones are located in two clusters in the northwestern and eastern sectors of the facility and are undissected to poorly dissected by erosion (Figure 2-8). The basaltic volcanoes at NADA are a portion of the larger San Francisco volcanic field (Wolfe et al., 1987).

Basalt flows are medium- to dark-gray where fresh, and are reddish-, yellowish-, and brownish-gray where weathered. Cinder cone materials are gray to red, becoming yellowish-brown where weathered. Basaltic flows are typically massive to fractured, and flow tops are generally weathered and partly mantled by poorly consolidated and locally weathered pyroclastic, eolian, alluvial and colluvial materials. A collapsed lava tube has been recognized just north of NADA Warehouse Area in the south-central part of Section 26, Township 23 North, Range 5 East, in a Quaternary basalt flow map unit known to underlie the NADA Warehouse Area (Wolfe et al., 1987).

Interbedded between Tertiary and Quaternary basalt flow units in the Ammunition Workshop Area is a recently recognized clay bed called the Clay of Navajo Army Depot by Wolfe et al. (1987). This yellowish-gray bentonitic clay is a weathered rhyolitic ash and coincides with the cluster of springs at Reservoirs 1, 2 and 3, which is the primary water supply at NADA (Figure 2-8). In this area, the clay bed appears to act as an underlying aquiclude that is responsible for the perched water table of the NADA water supply springs (Figure 2-7).

The Quaternary and Tertiary volcanic rocks at NADA were extruded onto an irregular erosion surface on the Permian Kaibab limestone. The Kaibab limestone outcrops under roughly one-third of NADA in the south-central portion of facility (Figure 2-6), and consists of yellowish-to light-gray, well bedded silty dolomite, dolomitic sandstone, and dolomitic limestone that is commonly cherty. Small, relatively insignificant areas in the southwest and southeast corners of NADA are underlain by the Triassic Moenkopi Formation, which overlies the Kaibab limestone (Wolfe et al., 1987). However, for the purposes of this report, the Moenkopi Formation is not shown on figures nor discussed further. The Kaibab limestone is locally fractured and jointed and hosts karst features such as sinkholes. Several sinkholes have been recognized in the southern portion of the Ammunition Workshop Area, and locally affect

surface hydrology and the collection and infiltration of runoff (USATHAMA, 1979) (Appendix B, Photograph 2).

Below the outcropping Kaibab limestone are the Permian Toroweap Formation, a well sorted, fine- to medium-grained sandstone with lesser siltstone and dolomitic facies locally, and the Permian-Pennsylvanian Coconino sandstone and Supai Formation, both predominantly sandstone, with some red shale and siltstone in the Supai (Figure 2-7) (Wolfe et al., 1987). These three formations were encountered in the NADA deep well and comprise a large portion of the thick vadose (unsaturated) zone above the regional water table at NADA. The Coconino and Supai Formations comprise the regional unconfined aquifer.

Local and regional geologic mapping have identified faults cutting Paleozoic sedimentary rocks as well as Quaternary-Tertiary volcanic rocks (Wolfe et al., 1987; Ulrich et al., 1984). Volcanic cones and vents regionally as well as locally cluster along fault traces and also at intersections of fault traces. No intrusive igneous rocks have yet been identified at NADA, but it is very likely that basaltic vents along faults have localized dikes and possibly sills cutting the Paleozoic sedimentary rocks and younger volcanic rocks. Any intrusive rocks such as these that might be present at NADA would be likely to have a significant local effect on the hydrogeology. Faults at NADA appear to have been a controlling factor for sinkhole formation, because the sinkhole cluster recognized in the Ammunition Workshop area is along the Bellemont fault (Figure 2-8).

Faults are regionally important with respect to groundwater resources and control infiltration and recharge as demonstrated by elongate groundwater mounds associated with faults, as well as by providing increased transmissivity in fractured zones from which pumping occurs (Akers, 1962; Akers et al., 1964; Montgomery and Dewitt, 1974; Scott, 1974).

The identified mineral resources of NADA are relatively limited. Ulrich et al. (1984) did not show any uranium resources at NADA or in the immediate vicinity. Cinders are or have been mined for road paving materials from Cinder Pits 1, 2, and 3 located in the western buffer area near Igloo Area E, Igloo Area B, and Igloo Area A, respectively. Cinder Pit 3, the site of some former landfill activity and a former pistol range, was designated Solid Waste Management Unit (SWMU) NADA-16 (U.S. Army Environmental Hygiene Agency (USAEHA), 1987). In the past, limestone has been mined from three pits at Quarry Tank in Igloo Area C, probably for use in concrete during igloo construction at NADA's inception (EBASCO, 1989b). Pits 1, 2, and 3 at Quarry Tank have also been the site of former waste disposal and were designated SWMU NADA-15 (USAEHA, 1987).

#### 2.4.6 Surface Water

Surface water features at NADA consist of intermittently flowing channels and many small springs that tend to discharge at topographic breaks in slope. Several of the springs have had small reservoirs constructed in order to catch their flow. No permanent bodies of water are known to exist other than the small spring-fed reservoirs. The springs and reservoirs were present prior to the establishment of NADA and were reportedly important historical sources of water for early settlers and previous Native American populations. The springs north of

the Ammunition Workshop Area were also sources of water for the Santa Fe Railroad at Bellemont Station before the Depot was constructed (EBASCO, 1989b).

Surface water flows at NADA are ephemeral and intermittent due to semiarid conditions. Since there is little or no groundwater or bank storage to maintain streamflow, flow occurs only during rainstorm events or in the spring season (snowmelt). Faults and fractures in limestone and volcanic vents have a major influence in the development of the drainage pattern.

Drainage on the installation generally flows from the north to the south, where normal runoff in the Ammunition Workshop Area goes into the sinkholes located southeast of the deep well (Figure 2-8). Volunteer Wash, which exits the southwest corner of the Depot, has a continuous channel through NADA and flows in a southwesterly direction to Sycamore Canyon. During periods of heavy surface flow, the capacity of the sinkholes is exceeded, and water floods across the low fault scarp into Volunteer Wash. Many poorly defined drainage channels carry intermittent flows of water but permanent streamflow is entirely lacking, as most of the precipitation is readily absorbed by the porous fractured lava and cinder beds (ESE, 1981). The Depot has no marsh or tile-drained areas (NADA, 1987c).

Approximately 96 square kilometers ( $\text{km}^2$ ) (37 square miles ( $\text{mi}^2$ )), or 84 percent, of the installation drain by way of 129 kilometer (km) (80 miles) of well vegetated drainage channels to the southwest into Volunteer Canyon. The remaining area, indicated on Figure 2-8, drains to the west. The central base area covers the lower portion of the Volunteer Wash watershed. The total area of the Volunteer Wash watershed to the discharge point at the southwest corner of the installation is about  $310 \text{ km}^2$  ( $121 \text{ mi}^2$ ); thus the base proper contributes less than one-third of the total flow to this point (USATHAMA, 1979).

Drainage is further complicated by interruptions to flow in the form of tanks (depressions that collect surface runoff) and sinkholes (depressions that allow rapid infiltration of water into the groundwater reserves). The various tanks, located throughout the installation, provide water for wildlife and cattle. Tanks are essentially natural shallow depressions (ponds) or holes in the ground that are fed primarily by surface runoff and are filled on a seasonal basis (USATHAMA, 1979).

Runoff for the site is less than would be expected, considering the topography and the amount of precipitation. Interruption or detention of runoff and absorption of water by the underlying porous soils are contributing factors. According to the SCS (1970), clay soils on-site absorb more water than would normally be expected. Many areas on NADA are covered with impermeable clays that restrict infiltration of surface water into the groundwater system. However, other areas of very porous basalts exist, which provide for rapid infiltration and recharge of the groundwater. Water entering these areas of high infiltration often re-emerges at bedrock outcrops as springs. The Ammunition Workshop Area has three springs just upgradient from the building complexes (ESE, 1981). As a result of all these factors, most flow never leaves the installation as surface runoff. Average runoff in this region is 3 centimeters (cm) (1.2 inches) or less per year. The lack of regular significant runoff has made stream flow records almost nonexistent (USATHAMA, 1979).

Storm runoff and snow melt provide the only measurable flows within the drainage basin. The installation has no serious flooding problems, although the drainage below Reservoir No. 1 spreads out during heavy flows (NADA, 1987c). Although flooding is rarely a problem at NADA, in the spring 1978 a heavy snowmelt caused some flooding in the Standard Magazine Area. Localized backups generally occur because of plugged culverts or debris-clogged storm drains.

Such periods of flood runoff have provided the only available flow data for the drainage basin. In the mid-1960s, USGS placed a gauging station at the southwestern corner of NADA where Volunteer Canyon leaves the reservation. During the period from 1965 to 1974, only one recorded flow was reported; a crest stage discharge of 31,149 liters/second (1,100 cubic feet per second) occurred in October 1972 (USATHAMA, 1979).

NADA's industrial and potable water needs have always been supplied by three springs located on the north side of the Ammunition Workshop Area. Water from the springs is stored in Reservoirs 1, 2, and 3. These springs have been operating since prior to the initial construction of the installation in 1942. They produce relatively low, but steady, yields of water (total volume was estimated at 340,000 liters or 88,000 gallons per day). A number of storage facilities have been built throughout the installation to provide localized supplies of water for specific uses such as fire fighting (USATHAMA, 1979).

A number of springs flow from basalt in the northern section of the depot extending in a line from the western side of the vacated Indian Village to a point just north of Reservoir 1. Two tanks, Quarry Tank and Elsie Springs Tank, are spring fed and provide stockwater most of the year, as did Tappan Spring until it dried up in 1978. The locations of springs, tanks, wells, and reservoirs are noted on Figure 2-8 (USATHAMA, 1979).

Reservoirs 2 and 3 are fed by one spring each. Water from these facilities can be transferred by a piping system to Reservoir 1, which is supplied by three springs. Since NADA has been on reserve status, water flow from Reservoirs 2 and 3 into Reservoir 1 has been stopped, and water for distribution and chlorination is taken directly from the springheads that supply Reservoir 1. Since 1976, only two springs have been used, with the excess flowing into Reservoir 1. During June 1978, combined flow from these two springs was measured at 208 liters per minute (55 gallons per minute); the groundwater temperature was 7.8°C (46°F) (USATHAMA, 1979).

Previous studies reported Spring 1 at Reservoir 1 discharged at 100 gallons per minute in 1949 at 48°F (Feth et al., 1954). Recharge to the springs is directly proportional to the precipitation. Rainfall during the period of January to June 1953 was 3.13 inches, and spring production for May and June 1953 was 81,000 gallons per day, or 56 gallons per minute. The following year, during the same time periods, precipitation was measured to be 9.55 inches, and spring production was 197,000 gallons per day, or 136 gallons per minute (ESE, 1981).

#### 2.4.7 Groundwater

The hydrogeology of NADA is complex and has not been thoroughly studied on either a regional or local basis. This section summarizes the hydrogeology as it is known and is drawn from previous studies at NADA, regional work by USGS, various regional university theses, conceptual modeling by the ADEQ, well records from the ADWR, and interviews with various groundwater professionals knowledgeable of regional conditions. It is important to characterize the hydrology at NADA because vadose zone water and groundwater could provide a potential pathway for migration of any contaminants that might be present in soils or facilities at NADA. A schematic depiction of the known aspects of NADA hydrogeology is included as Figure 2-7.

The regional water table, occurring in the Coconino-Supai sandstone aquifer, is encountered at approximately 1,270 ft in the NADA deep well. Several perched water tables, controlled by local geologic conditions, are present in the vadose zone above the regional unconfined aquifer. These perched saturated zones have been identified at various depths to 350 ft, and are the predominant source of groundwater in wells immediately adjacent to the Depot (Figure 2-9). Information derived from ADWR and NADA records on water supply and monitoring wells located on and within one-half mile of NADA is included as Appendix C. The regional Coconino-Supai aquifer is exploited elsewhere in the region such as at Flagstaff's Woody Mountain Well Field, 5 miles southeast of the eastern NADA boundary. The perched zones are discussed below in descending order.

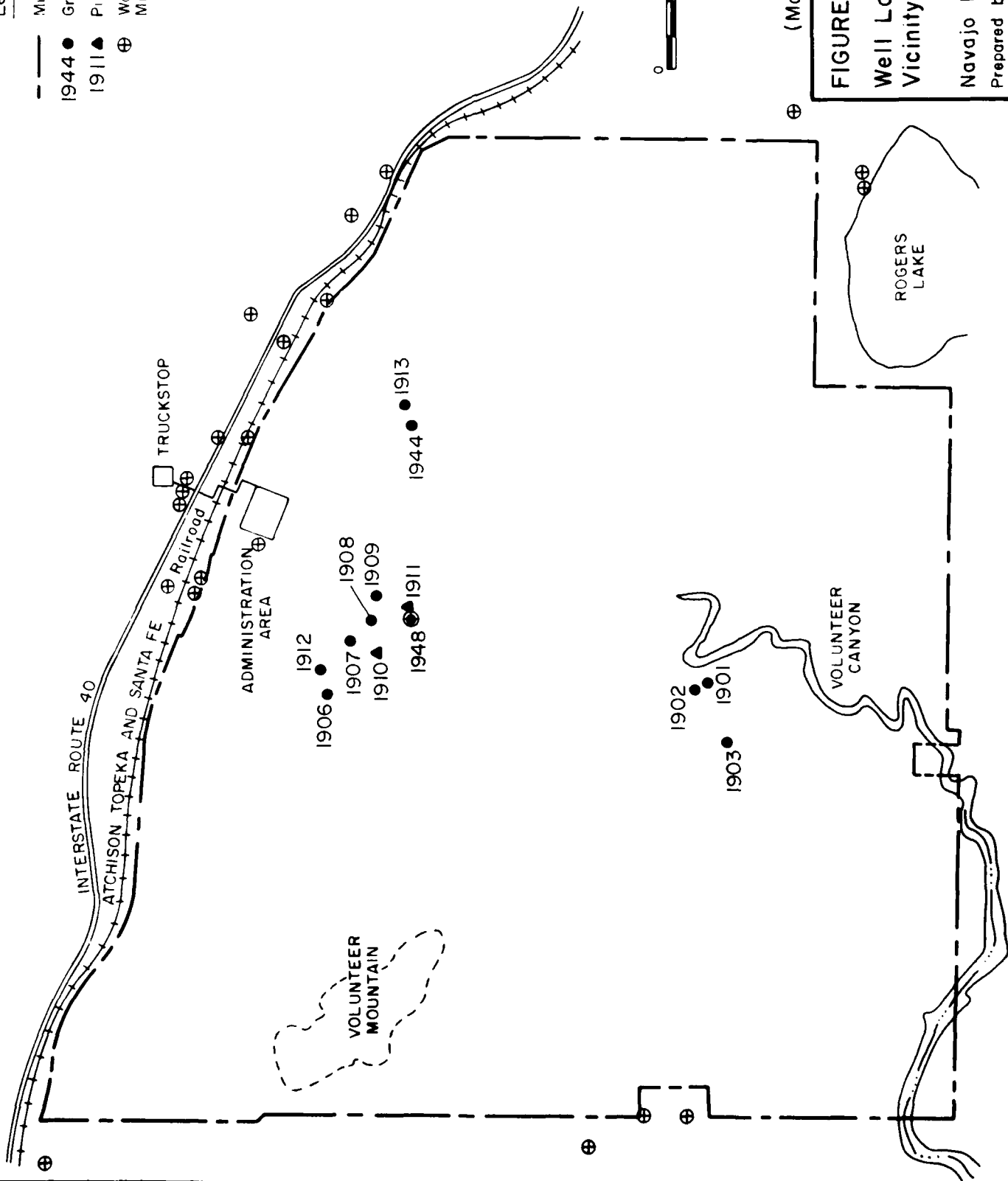
At and near NADA, perched water tables are found in unconsolidated or alluvial deposits, as indicated by monitoring wells south of the Ammunition Workshop Area. In wells north of NADA at Bellemont, and at the springs that discharge at Reservoirs 1, 2, and 3, groundwater is encountered within horizons in Quaternary and Tertiary basalt flows and volcanoclastic sediments. Other wells, such as some wells north and northeast of NADA, produce water from perched zones found in the Kaibab limestone, above interbedded chert and siltstone lenses (ADWR, 1989; Graf, 1984; Graf, 1989).

The groundwater flow in the alluvial and volcanic perched aquifers generally tends to mimic topography. On a local scale, upland areas such as the volcanic cones and ridges are the recharge points for the shallow aquifers on-site. In general, the shallow groundwater in the northern NADA area flows toward the south from recharge areas north of the Depot. The springs at Reservoirs 1, 2, and 3 illustrate this flow pattern. Interaction between the various saturated zones at NADA is generally characterized by recharge of underlying zones from the surface or overlying perched zones along fractured zones in volcanic and sedimentary rocks comprising the vadose zone.

Despite precipitation of 20 inches per year, much as snow, surface runoff at NADA is rapidly absorbed because of porosity and fracturing in the outcropping volcanic and limestone units. Infiltration of precipitation and subsequent recharge of shallow perched zones is rapid, as shown by fluctuating spring discharge at Reservoir 1 in direct response to rainfall quantities in 1953 and 1954 (ESE, 1981), as discussed in Section 2.4.6. Surface flow downstream of the Ammunition Workshop Area, where the Kaibab Limestone is first exposed in Volunteer Canyon, is infrequent because most of the flow disappears into joints, solution enlarged fractures, and sinkholes in the limestone (Graf, 1984). Water levels in the NADA deep well have not been monitored to determine if infiltration of water into the sinkhole causes any

# Legend

- Military Reservation Boundary
- 1944 ● Groundwater Monitoring Well
- 1911 ▲ Pilot Boring/Piezometer
- ⊕ Water Supply Well Within 1/2 Mile of Perimeter



(Modified from ESE, 1981)

FIGURE 2-9

## Well Location Map for Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental

measurable fluctuations in the water table in response to storm or runoff events comparable to the spring discharge fluctuations at Reservoir 1.

Graf (1984) has compiled a conceptual model of the hydrogeology at NADA. The following discussion is taken largely from his work.

The alluvium is the youngest unit, filling low-lying swales as occur south of the Ammunition Workshop Area, and forming a thin mantle overlying consolidated rocks, as in the Demolition Area. The generally coarse nature of the alluvium aids infiltration and transmission of water from precipitation into the underlying units. In general, the alluvium should not be considered a barrier to the downward movement of water.

Saturated zones occur where the alluvium is underlain by less permeable strata or where silt or clay lenses within the alluvium give rise to transitory or discontinuous perched water bodies. The shallow monitoring wells in the meadow south of the former TNT Washout Lagoons in the Ammunition Workshop Area tap the latter type of groundwater body. The areal extent of this saturated zone is small, as indicated by Monitoring Well 1910, which failed to encounter groundwater (Figures 2-7, 2-9).

None of the shallow monitoring wells in the Demolition Area encountered groundwater. In this area, infiltrating water moves through the mantle of alluvium into fractures and joints of the underlying Kaibab Limestone.

The volcanic units include cinder deposits, consolidated lava flows that may or may not be fractured, and interflow beds of clay, cinders, gravel, and soil. The local volcanoclastic horizons within the volcanic rocks control the perched zones. Some of the volcanoclastic sediments with low permeability, such as the Clay of Navajo Depot identified by Wolfe et al. (1987), act as barriers to downward percolation, and thus give rise to temporary or in some cases permanent perched groundwater. Other interbedded volcanoclastic sediments are highly permeable and yield water to wells (Akers et al., 1964). However, most of the water in volcanic rocks occurs in fractures in the NADA vicinity (Akers et al., 1964). Usually, however, the volcanics provide little hindrance to the downward movement of infiltrating water, particularly where cinders predominate, such as at the Former NADA Sanitary Landfill.

The Kaibab Limestone occurs throughout NADA, either exposed on the surface or underlying alluvium or volcanics. The formation is probably about 400 ft thick in the NADA area. The Kaibab is a brittle formation and is strongly jointed and fractured. In some places, the fractures have been widened by solution into sinkholes, such as at the large sinkhole complex south of the Ammunition Workshop, where excess surface runoff cascades into a sinkhole. These fractures and sinkholes facilitate rapid recharge to the underlying Coconino aquifer. Generally, the Kaibab Limestone is not under saturated conditions, however, chert layers and lenses of siltstone can produce small bodies of perched groundwater. An unused well located between the Administration Building Area and the Warehouse Area at NADA seems to be completed in a zone of perched water within the Kaibab Limestone.

Beneath the Kaibab Limestone is the Toroweap Formation, which in the NADA area is a sandstone nearly indistinguishable from the underlying Coconino sandstone. In this brief report, it is not described separately. The Coconino sandstone, in combination with the uppermost part of the underlying Supai Formation, is the main deep aquifer of the San

Francisco Plateau and Flagstaff Area. In the NADA area, the water in the aquifer is under water-table (unconfined) conditions, and lies at a depth of about 1,273 ft below land surface as measured in 1950 (ADWR, 1989).

The City of Flagstaff Woody Mountain Wellfield, located about 3 miles east of NADA (Figure 2-1), withdraws municipal supply water from the Coconino aquifer. Recharge to the Coconino aquifer is by percolation of water downward from overlying units. Recharge regionally appears to be enhanced along fault zones as shown by the prominent groundwater mounds associated with Lake Mary and Rogers Lake (Akers, 1962). Hydrogeologic information acquired through the construction of the NADA deep well in 1950 was used to locate and complete the Woody Mountain Wellfield wells (Feth, 1961).

Very little is known about flow directions and gradients in the perched aquifers overlying the Coconino aquifer, but it is likely they roughly mimic topography. Within the Coconino aquifer, groundwater flow is probably to the north or northeast as it is in the Flagstaff Area, but could very well be influenced by faults in and around the NADA area. Appel and Bills (1981) depict a regional gradient to the north in the NADA vicinity, but data are sparse.

The productivity of the Woody Mountain Wellfield is attributed to enhanced recharge and transmission of groundwater along a major north-south fault zone, the Oak Creek Fault. The large sinkhole complex, located just south of the former Ammunition Workshop TNT Wastewater Lagoons, developed along the Bellemont Fault, another north-south fault zone. The projected trace of the Bellemont Fault is likely intersected 1-1/2 miles south of the sinkhole complex by an east-west fault, the Dunnan Fault, crossing through the southern part of NADA (Wolfe et al., 1987). Preferential vertical and lateral movement of groundwater along these fault zones is probable, based on knowledge of the regional hydrogeology.

Evidence of possible past contamination of the deep Coconino aquifer by now discontinued surficial disposal activities is provided by a fluorescein dye test conducted by USGS in 1951 (ESE, 1981). In that test, fluorescein dye was introduced into a gravel-filled basin about one mile north of NADA's water supply springs and 1-1/2 miles north of the Ammunition Workshop. The dye spread widely through the gravel and volcanics in the area, and was detected in the spring water for many months afterward. The dye subsequently showed up in water pumped from the deep well tapping the Coconino aquifer, implying the existence of hydraulic communication between the land surface and the Coconino aquifer.

The avenue of transmission of the dye to the deep well was not conclusively shown in the study, however. The report indicated recharge through the karst features of the Kaibab limestone to be the pathway for the dye. However, it should be noted that poor well construction techniques, such as lack of a grout seal, is also a possible avenue. Records of well construction indicated no grout seal for the main well casing and records of maintenance indicated that the well casing dropped several feet during servicing, implying a poor casing-bedrock seal (EBASCO, 1989b). Cross-contamination of water samples is also a possible explanation of the dye presence in the well water because sample handling and equipment decontamination procedures were not documented in the early 1950s study (Graf, 1989).

Previous hydrogeologic studies at NADA are limited. Eleven monitoring wells (Figure 2-9) were installed in three areas to determine hydrogeologic conditions in the uppermost water-bearing zones and whether any groundwater contamination had resulted related to past NADA

waste management practices (ESE, 1981). In that study, wells were installed near the Ammunition Workshop Area, the former Sanitary Landfill in the Standard Magazine Area, and in the Demolition Area. However, the wells in the Demolition Area did not encounter water.

Wells in the Ammunition Workshop Area have been monitored during a subsequent investigation (Malcolm Pirnie, 1989). Wells in the Ammunition Workshop Area have shown water level fluctuations in response to seasonal precipitation and runoff infiltration. No potentiometric surface (water level elevation) maps have been presented in the previous hydrogeologic investigations at NADA to verify groundwater flow directions or gradients.

Groundwater usage is regulated in Arizona by the ADWR, which issues permits to drill and complete wells. The ADWR keeps records of well completion permits and groundwater levels in databases that were accessed to provide information for this report. Issues of groundwater quality are regulated in Arizona by the ADEQ.

#### 2.4.8 Cultural Resources

Cultural resources include prehistoric and historic archaeological sites, historic sites (other than archaeological sites), architecturally significant structures, and Native American heritage sites. Since NADA has not been surveyed for cultural resources sites, it is unknown whether significant sites exist there. However, the prehistory and history of the Flagstaff region, as well as archaeological survey information from surrounding areas, indicate that certain types of sites might be located there. One site within NADA, the Volunteer Mountain Lookout Cabin, was placed on the National Register of Historic Places on January 28, 1988 (Arizona State Historic Preservation Office, 1990). Archaeological sites and historic properties are protected under provisions of the Programmatic Memorandum of Agreement with the Advisory Council on Historic Preservation executed in February 1990.

##### 2.4.8.1 Prehistory

Arizona prehistory begins roughly 11,500 years ago, when Native Americans of the Paleoindian period entered North America. Paleoindians depended upon wild food gathering and the hunting of species of Pleistocene megafauna that are now extinct (such as mammoth, mastodon, giant bison, etc.) for subsistence. Paleoindian sites are known throughout Arizona, including the Flagstaff region.

The succeeding period of Arizona prehistory (8000 B.C.- A.D. 1) is called the Archaic period. Native Americans adapted to drier conditions and the extinctions of large game species during this long period, marked by low population density and slowly evolving technology.

Population began to grow more rapidly during the Basketmaker Period (A.D. 1-750). Prehistoric life was increasingly sedentary during this period, as larger villages of pit houses began to develop. Small-scale horticulture (maize, beans, squash, and other cultigens) first began in earnest during this period, though domesticated maize is known in southern Arizona from contexts dating as early as 3000 B.C. Widespread pottery use also begins during the Basketmaker Period, as does the use of ceremonial structures and metates (seed grinding slabs).

The succeeding Pueblo period (A.D. 750-1600) brought a dramatic increase in and geographical expansion of horticultural populations, followed by a relatively sudden collapse of hinterlands agriculture, the aggregation of populations near the most favorable agricultural locations and the re-establishment of a semi-nomadic way of life in some areas. The period

of population expansion took place between A.D. 750 and 1000, during which the population expanded by a factor of between four and forty in most areas and became widely distributed (Martin & Plog, 1973). There were then two major episodes of hinterlands abandonment and population aggregation, 1000-1150 and 1240-1350, that were partly the result of worsening climatic conditions.

Prehistoric cultures of the Pueblo Period in the Flagstaff region are called Sinagua, which is generally considered a subculture of Puebloan most similar to the Mogollon archaeological culture centered further east. After the eruption of Sunset Crater in A.D. 1046-1070, much of the area was abandoned because the ground and vegetation had been covered in volcanic ash. The area then experienced an enormous population increase between 1100 and 1200, as Native Americans found that the volcanic ash was very fertile for farming. By 1300, the cinders began to form dunes, exposing poorer soil below, and the area near Flagstaff was nearly abandoned. Many archaeologists believe that most of the Sinagua people moved south into the Verde Valley at this time.

Native American life in the region after A.D. 1350 centered around several major Puebloan centers, such as Zuni and the Hopi Mesas, until the 1600s, when the arrival of the Spanish from the south and groups of Navajos migrating southward from the Great Plains ushered in a new era.

#### 2.4.8.2 History

After the Puebloan collapse, the Flagstaff region was mostly unsettled until the arrival of cattlemen, sheepmen, and the transcontinental railroad in the 1880s. Several Spanish explorers passed through the area in the 1500s, 1600s, and 1700s, including members of the Coronado expedition of 1540-42, Espejo in 1581-82, Onate in 1604-06, Garces in 1775-76, and Escalante in 1776 (Trimble, 1977). Captain Lorenzo Sitgreaves passed through the area in 1851 looking for a military wagon route between Zuni Pueblo and the Colorado River. Lt. Beale surveyed a similar route in 1858.

According to some accounts, Beale's men lashed a flagpole to a pine tree near a well known spring and watering hole. According to other accounts, the flagpole was erected on July 4, 1876, by a group of scouts awaiting a wagon train carrying settlers from New England. When a post office was opened in 1881 near the spring, the place was called Flagstaff (Barnes, 1935).

The Flagstaff area was first settled in the 1870s and 80s by cattle ranchers moving west from New Mexico, many of them originating in Texas (Comeaux, 1981). The Atlantic and Pacific Railroad (later the Atchison, Topeka, and Santa Fe) set up camp in Flagstaff in 1882, and opened the area to increased settlement. The economy of the region subsequently centered around cattle and sheep ranching and the lumber industry.

#### 2.4.8.3 Cultural Resources of the NADA

Several types of cultural resources might be expected within the NADA. Archaeological surveyors working in areas immediately west, south, and east of the NADA have recorded numerous small lithic scatters, widely distributed for the most part across the landscape (Rozen, 1990). Many of these sites might be campsites and kill sites associated with hunting, and many date to the Archaic period. Others might be sites located along prehistoric trade routes between the Verde Valley and the major obsidian source at nearby Government

Mountain that ran through Sycamore Canyon directly to the south of the NADA (Bremer, 1990) or a route between Verde Valley and the Hopi Mesas. Ceramic Period habitation sites, such as pit house villages and Puebloan Period room blocks, are less common in this area than they are to the northwest and northeast but might be expected near major springs. Prehistoric sites are more common along the margins prairies, meadows, and lakes, such as Rogers Lake and Garland Prairie.

Since success in early ranching to some extent depended upon gaining control of major sources of water on the range, historic sites might be expected near the NADA springs. The Overland Trail, a military wagon road built in 1863 between Prescott, then territorial capital, and Flagstaff, then called Antelope Springs, crosses NADA, and there may be associated sites adjacent to it, particularly near springs (Lesko, 1990). Historic homesteads are fairly common in the NADA locality, particularly at the margins of prairies and meadows. Railroad beds and railroad work camps associated with early logging activities are also common historic site types in the areas surrounding NADA.

Several historical features mentioned below were observed by EBASCO investigators during the site visit after interviews with knowledgeable NADA personnel. Near Reservoir 3 in the Ammunition Workshop Area, a rectangular low stone wall is present, possibly representing remnants of a barn or livery. In Igloo Area B, tumble-down remains of a cabin and corral fencing are located nearby an ephemeral spring (Appendix B, Photographs 3, 4). The bed of a former narrow gauge railroad was observed in the south-central part of NADA. A former Post-Depression Era Civilian Conservation Corps (CCC) camp is present in the northern part of Igloo Area C. The former CCC camp is also discussed in Section 3.8.4 because of recently observed remnants of a fueling island with possible USTs. Interviews with Depot personnel also indicated sites exist on the installation with signs of possible former Native American campsites or kill sites.

#### 2.4.9 Biota

A Fish and Wildlife Management Plan (NADA, 1987a) and a Forest Management Plan (NADA, 1987b) were done on NADA. While oriented toward game species and commercial species, respectively, this information is also pertinent for nongame species that utilize similar habitats and have similar food and cover requirements. The information that follows was extracted almost entirely from these plans. Additional input was supplied by personnel of the U.S. Fish and Wildlife Service (USFWS). Hunting, fishing, or trapping are not currently available to the public, but are available to Depot personnel and members of the National Guard.

The principal vegetation community-type on NADA is ponderosa pine forest. Gambel oak, pine, and aspen and Gambel oak and ponderosa pine communities also occur on NADA (NADA, 1987b). Other tree species within these communities include Douglas fir, white fir, blue spruce (introduced), alligator juniper, one-seed juniper, and turbinella oak. Grass species include Arizona Fescue, blue grama, mountain muhly, western wheatgrass, pine dropseed, cheatgrass, and squirreltail. Legumes include New Mexico locust, red and yellow pea, and yellow sweetclover. Forbs include western yarrow, flannel mullen, spreading fleabane, sunflower, goldenrod, silvery lupine, and pingue, with characteristic shrubs and half-shrubs being cliffrose, buckbrush, mountain mahogany, and rabbitbrush.

Cattle grazing occurs on three units totaling about 20,000 acres. A yearly Grazing Lease Management Annual Work Plan (NADA, 1989b) outlines projects for implementing proper range management on NADA. Wildlife benefits directly from proper range management as well.

Information was requested from the USFWS regarding endangered or threatened species that could possibly be affected by the NADA base closure/realignment. They reported that their data indicated no such species in the area of interest would likely be affected (Appendix D). Mr. Lee Leudeker (personal communication, 1989), Wildlife Manager with the Arizona Game & Fish Department in Flagstaff, Arizona, reported some use of the NADA vicinity by wintering bald and golden eagles as well as use by spotted owls and goshawks. The latter two species are sensitive to forestry practices. Mr. Leudeker identified Volunteer Canyon in the southern part of the NADA as a rather unique habitat-type, which he described as a "mixed conifer savannah" consisting of open grassland interspersed with blue spruce, Douglas fir, and white fir.

Three spring-fed reservoirs located within the restricted area support fishing. Two of the reservoirs are stocked twice a year with rainbow trout. The third is stocked with catfish and bass. Ducks and geese use these three reservoirs, as well as fourteen water tanks in the buffer zone. The ephemeral ponding that occurs in the sinkhole complex south of the Ammunition Workshop Area has been identified as a marsh called "Atherton Lake" (NADA, 1987a) (Appendix B, Photograph 5). The Fish and Wildlife Management Plan (NADA, 1987a) categorized Atherton Lake as a waterfowl breeding area. The listing of the sinkhole complex as a marsh by the Fish and Wildlife Management Plan (NADA, 1987a) conflicts with the statement in the Forest Management Plan (NADA, 1987b) that no marsh areas exist on NADA. Vegetation typical of marshy areas is not present in the sinkhole complex, and aerial photography available to the Ebasco PA team shows standing water rarely present in the sinkholes (EBASCO, 1989b). However, seasonal ponded water present in the sinkhole complex may coincide with waterfowl nesting periods and thereby provide timely habitat for these activities.

Game species are more abundant on NADA than in surrounding areas. At least three reasons are probable: restricted access combined with low hunting pressure, facilitated game movement via the connection between Volunteer Canyon and the Sycamore Canyon Primitive Area, and management for wildlife (NADA, 1987a).

Big game are abundant on the NADA. No census of big game populations has been conducted at NADA, but estimates have been made. Approximately 600 to 750 elk use the Depot as summer range. A smaller number of elk use the Depot as winter range. Deer use the Depot as summer range also, but to a more limited extent than elk. Approximately 30 Pronghorn antelope inhabit the NADA (Leudeker, 1989). Black bear are also present.

Important small game species include wild turkey, Abert squirrel, cottontail, and jackrabbit. NADA attempts to control the following predator and pest species: coyote, grey fox, skunk, and badger. Predator control is practiced to protect elk, deer, and turkey populations. Other species inventoried on NADA include raccoon and porcupine.

## 2.5 ENVIRONMENTAL STUDIES AT NADA

Over the years, several reports have been written summarizing various aspects of the NADA environment that have been studied and investigated. They serve to describe important environmental features of NADA as well as provide baseline information from which to assess environmental impacts. Although many of the environmental problems described were subsequently corrected or are now being remediated, these studies serve as a history of environmental concerns at NADA. The previous reports should be read from that perspective. All supporting documents for the PA are listed in Appendix A and include the reports and studies listed below. Much of the environmental setting description of Section 2.0 was garnered from past NADA investigations, although other regional information was incorporated as well. Section 3.0 descriptions of AREEs reference these studies where appropriate. Appendix A also provides a brief synopsis of the content of the supporting documentation and supplements the list of references given at the conclusion of the report text.

The reports and studies listed below have been subdivided into categories according to their content. Many studies contain information that would allow them to be placed in more than one category, but they were placed in the grouping that best corresponds to the main thrust of the study. Individual reports within each category that contain critical information or are particularly key to the construction of this PA are briefly described.

### 2.5.1 General Environmental Assessments

Several assessments of the overall environmental status of NADA have been completed. These investigations generally compiled NADA records and pertinent regional data to provide appraisals of the environmental setting and status of the facility, and gave accounts of past and ongoing activities that may have caused environmental impact. The first two studies listed below were conducted on an installation-wide basis in 1979 and 1982. The third study was completed for the proposed 1988 construction of the ANG Bellemont Armory Weekend Training Site (WETS) within the northeast part of NADA.

- Installation Assessment of Navajo Depot Activity, Report No. 137, U.S. Army Toxic and Hazardous Materials Agency, December 1979
- Installation Environmental Assessment for Navajo Depot Activity, Inland Pacific Engineering Company, November 1982
- Environmental Assessment for WETS, Navajo Army Depot Activity, Bellemont, AZ, Draft Report, Arizona Army National Guard, August 1988.

### 2.5.2 Hazardous Waste/Solid Waste Investigations

Various studies have been completed at NADA that investigated possible contamination, which may have been the result of past waste management practices. Most of the studies were site and media specific, with the exception of the Aerial Photographic Analysis of NADA and Evaluation of Solid Waste Management Units at Navajo Army Depot Activity, which were installation-wide. The investigated media included soil, surface water, and groundwater. The sites where most of the media sampling programs were completed included locations in the Ammunition Workshop Area, Demolition Area, and the Standard Magazine Area. Each of the studies generally included some characterization of the investigated media.

- Aerial Photographic Analysis of Navajo Army Depot, Interim Report TS-PIC-89334-B, James D. Peroutsky, Bionetics Corporation, September 1989
- CERCLA Facility Investigation Inspection Report for Navajo Depot Activity, U.S. Environmental Protection Agency, April 1982
- Contamination Evaluation for Navajo Depot Activity, Contract No. DACA87-87-C-0086, Final Report, Volumes 1 & 2, Malcolm Pirnie, March 1989
- U.S. Army Material Development and Readiness Command (DARCOM) Open Burning/Open Detonation Grounds Evaluation for Navajo Army Depot Activity, Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, U.S. Army Environmental Hygiene Agency, September 1981
- Environmental Survey of Navajo Army Depot Activity, Environmental Science and Engineering, Inc., September 1981
- Evaluation of Solid Waste Management Units (SWMUs) at Navajo Army Depot Activity, Ground-Water Contamination Survey No. 38-260878-88, Interim Final Report, U.S. Army Environmental Hygiene Agency, October 1987
- Investigation and Evaluation of Underground Storage Tanks at Navajo Army Depot Activity, U.S. Army Corps of Engineers, September 1989
- Soil Gas Survey at the Navajo Depot Activity, Hydro Geo Chem, Inc., May 1989
- Synthetic Organic Chemicals Survey at Navajo Depot Activity, Drinking Water Surveillance Program (DWSP), U.S. Army Environmental Hygiene Agency Memorandum of Results, June 1989.

## 2.6 PERMITTING STATUS

In August 1983, NADA filed a RCRA Part B Permit Application for the incineration of waste munitions and storage of the resulting ash residue. The Army has since decided not to upgrade NADA's Deactivation Furnace to meet RCRA requirements, and the Arizona Department of Environmental Quality has denied this permit application (ADEQ, 1989). The deactivation furnace and ash residue in the ammunition workshop area are now undergoing closure under RCRA. Work is scheduled to begin in spring 1990.

A separate RCRA Part B Permit Application for open burning and open detonation activities at NADA was filed in October 1988 (EDGE, 1988). These activities are continuing under RCRA interim status pending a decision by the ADEQ on the permit application. The EPA Identification Number assigned to NADA for these permits is AZ7213820635.

NADA has two current air pollution control operating permits from the ADEQ. Permit Number 84009-89 is for open burning and detonation of munitions. Permit Number 84008-89 is for operation of three boilers and the now unused deactivation furnace. Both of these permits are issued annually and expire in March 1990.

In March 1975, NADA was issued an EPA permit (National Pollution Discharge Elimination System (NPDES) Permit Number AZ0110353) for operation of the sewage treatment plant. Effluent from the plant was discharged into a dry tributary to Volunteer Canyon. In late 1975, evaporation lagoons were constructed to eliminate the discharge, and the required permit was revoked in February 1976.

Solid waste generated at the facility is hauled to the Flagstaff Municipal Landfill by a private contractor. Use of the Former Sanitary Landfill on-site was discontinued in 1966. There is an active construction debris landfill near the sewage plant evaporation lagoons. This landfill does not require a permit under the Arizona Solid Waste Regulations (USAEHA, 1987).

### 3.0 AREAS REQUIRING ENVIRONMENTAL EVALUATION (AREEs)

The following AREEs have been identified at the Navajo Depot Activity through research of historical information and interviews with past and present employees. The AREEs are organized and presented according to the mission activity conducted in each area.

#### 3.1 AMMUNITION DEMOLITION

The Demolition Area at NADA (Figure 3-1) is located in the southern portion of the installation and abuts the Coconino National Forest (Figure 2-2). Volunteer Canyon bisects the area, running north and south. The Demolition Area has been the site of virtually all munitions-related demolition. The discussion of the Demolition Area is divided into open detonation (OD) areas and open burning (OB) areas. Solid waste disposal has also occurred in the Demolition Area and is discussed in Section 3.7.1.5. The Demolition Area is large, but activities were mostly confined to discrete sites. Several previous investigations have identified and characterized these discrete sites, and most have been designated as SWMUs and given numbers (USAEHA, 1987). For example, the Former WP Detonation-Burn Area SWMU was designated as NADA-7. Each AREE listed below is cross-referenced to its SWMU number if one has been designated.

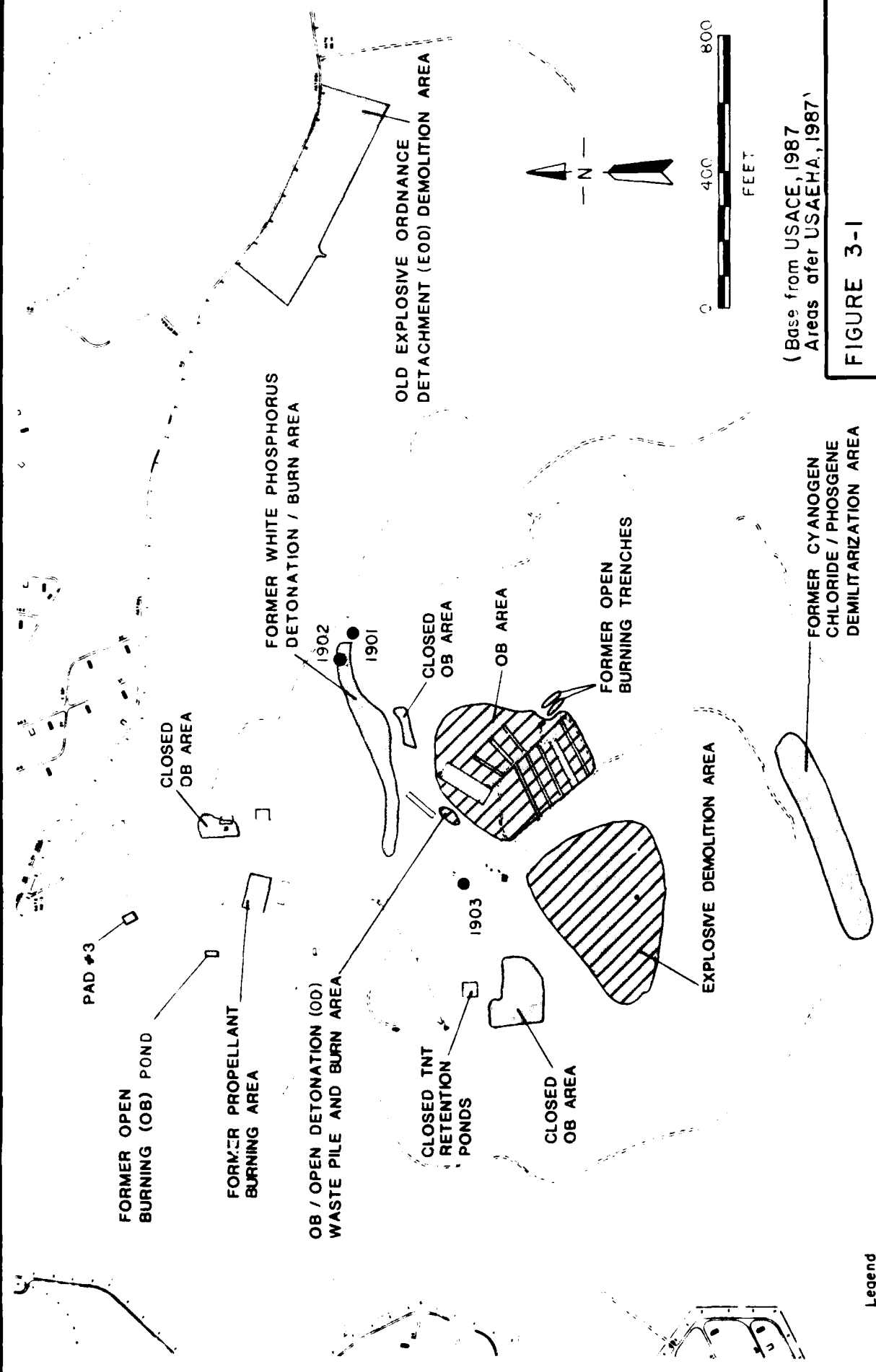
A RCRA Part B Permit Application has been submitted by NADA for the continuance of ordnance destruction in the Demolition Area (EDGE, 1988). No decision has been made by the EPA and ADEQ concerning the permit.

##### 3.1.1 Open Detonation

All open detonation activities have been conducted to the west of Volunteer Canyon except for a short period from 1942 to 1945, and again in 1961, when some demolition was done in the Old Explosives Ordnance Detachment (EOD) Demolition Area, a small area to the east and north of the mouth of Volunteer Canyon (NADA-5). The demolition done in this area was primarily the disposal of HE-filled ammunition up to 155 millimeter (mm); some WP-filled projectiles and small arms ammunition were also disposed occasionally. There was some training-related firing of .50 caliber machine guns into the bordering banks. The area was also utilized by the 77th EOD Team for demolition and training during its tenure at the depot. The EOD Team departed the Depot in the early to middle 1970s (USATHAMA, 1979).

The Explosives Demolition Area (NADA-11) (Appendix B, Photograph 6) is currently used for explosive destruction of HE-filled ammunition, fuzes, primers, detonators, and other "live" ammunition and components. The limits imposed upon demolition operations, are 5,000 pound (lb) (2,268 kilograms (kg)) aboveground, and 10,000 lb (4,536 kg) below ground. This limit is never exceeded, and 1,200 lb (454 kg) has been the maximum detonated at any one time.


The Former WP Detonation/Burn Area (NADA-7) (Appendix B, Photograph 7), informally referred to as the "Dam" or "Chemical Canyon" by past NADA personnel, was used for destruction of ammunition and bombs from 1945 to the mid 1970s. WP and PWP munitions were detonated and burned in this area. During interviews with both retired and active personnel who have worked in the area, frequent mention was made of the possibility of igniting small quantities of WP and PWP by walking through the area and stepping on unburned material, thus breaking the coating on the surface and exposing the phosphorus to the air (USATHAMA, 1979). Barrels for water were previously kept in this area. Retired NADA personnel stated that these were used to put out fires resulting from WP and PWP



(Base from USACE, 1987  
Areas after USAEHA, 1987)

**FIGURE 3-1**  
**AREEs in Demolition Area**

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

- Legend**
- 1901 ● Monitor Well (dry)
  -  Currently Active Areas

disposal (EBASCO, 1989b). Some of these barrels along with materials scraped from the adjacent closed Open Burning Area have been landfilled into the southwest wall of the canyon at the Former WP Detonation/Burn Area.

One or two mustard (H)-filled 250 pound bombs were detonated and burned in the Former WP Detonation/Burn Area during the middle 1950s. These bombs were suspected "leakers" and were brought directly to the Demolition Area, placed on a large pile of wooden dunnage, and detonated. The dunnage was then burned. No subsequent decontamination of the area was performed. Surveillance Branch personnel ran H-detection tests in the area and no evidence of mustard contamination was reported (USATHAMA, 1979).

During a period of six to eight months in the early 1950s, the Former Cyanogen Chloride/Phosgene Demilitarization Area (NADA-9) in the southern portion of the Demolition Area was used for the destruction of an unknown quantity of CG-and CK-filled 500 and 1,000 pound aerial bombs. The bombs were aligned on the ground, charges placed on the top and both ends of each bomb, then detonated. This process opened the bombs and allowed the agent contained within to vent into the air. The empty casings were then burned and the scrap sold through the Defense Property Disposal Office (DPDO) (USATHAMA, 1979). Reports of vegetation discoloration were noted, but a subsequent investigation failed to yield any conclusive evidence of contamination (ESE, 1981). Numerous Chemical Munitions Warning Tags were found in the vicinity of the CG/CK disposal area during the PA field visit lending evidence for this disposal activity in this area (EBASCO, 1989b).

Sampling of shallow soils in the Explosives Demolition Area has been conducted (USAEHA, 1987). Analytical results from the soil samples indicated metal contamination levels were below Extraction Procedure (EP) toxicity test levels. Explosives-related compounds were not detected. The negative results from open detonation sites contrast with explosives residues detected at open burning sites (see Section 3.1.2). Open detonation is more likely to fully consume all explosive compounds than burning.

Soil sampling in the Former WP Detonation/Burn Area showed the presence of TNT, nitrate plus nitrite, and total phosphorus. Groundwater has not been sampled because the three monitoring wells in the area are dry (ESE, 1981).

### 3.1.2 Open Burning

The Open Burning Area (NADA-12) is currently used for the burning of explosives-contaminated materials and containers. Burning is conducted in four burn pans with a bulk dry propellant as fuel. An old burn cage (Appendix B, Photograph 8) is also present on this site.

In 1987, a heavy equipment operator reported a skin reaction after conducting grading activities in the burn cage area. A companion demolition worker reported no reaction. All demolition activities were suspended to allow for investigation and subsequent sampling of the area (U.S. Army, 1987). The investigation and results indicated the cause of the skin reaction was a pre-existing medical condition and was unrelated to Demolition Area activities (EBASCO, 1989b).

Soil sampling has been conducted in the Open Burning Area within the Demolition Area (ESE, 1981; USAEHA, 1987). Most metals were below the EP Toxicity level except for one sample with lead at 12.0 milligrams per liter (mg/L), which exceeded the EP Toxicity level of 5 mg/L. Also, explosives analyses detected cyclotrimethylene trinitramine (RDX), cyclotetramethylene trinitramine (HMX), tetryl, TNT, and dinitrotoluene (DNT). However, all samples but one were below the 20 micrograms per gram ( $\mu\text{g/g}$ ) total explosives content level (USAEHA, 1981). Groundwater has not been sampled because the three monitoring wells in the area are dry (ESE, 1981).

The OB/OD Waste Pile and Burn Area (NADA-10) (Appendix B, Photograph 9) is a currently active site where waste materials from burning and detonation operations are disposed. Pallets, wire, wood, containers, shrapnel, and other explosives-contaminated materials are piled, burned, and landfilled at this site. All other burning-related sites in the Demolition Area are not currently active.

Wastewaters from the TNT Washout were transported to the Closed TNT Retention Ponds (NADA 3) and the Former Open Burning Trenches (NADA 8) after the 1953 installation of a closed circulation system. Liquids were allowed to infiltrate and evaporate and solids were periodically burned (see also Section 3.2.1). Soil samples collected from these sites have shown elevated levels of explosive compounds (ESE, 1981; USAEHA, 1981, 1987). Visual inspection during the PA site visit indicated small chips and flakes of explosives residue, and metal fragments were present at both sites (EBASCO, 1989b). Groundwater was not sampled because three wells in the vicinity are dry (ESE, 1981).

Pad 3, located west of the main road through the Demolition Area from Gate 13, is one of a series of staging pads formerly used for temporary storage of munitions scheduled for demolition. According to an interview with a former employee, this was the only pad where burning activities were also conducted (EBASCO, 1989b). In 1969, an Air Force shipment of five or six sodium arsenite drums was held temporarily on Pad 3 to correct a leak. The resulting ground contamination was treated with lime.

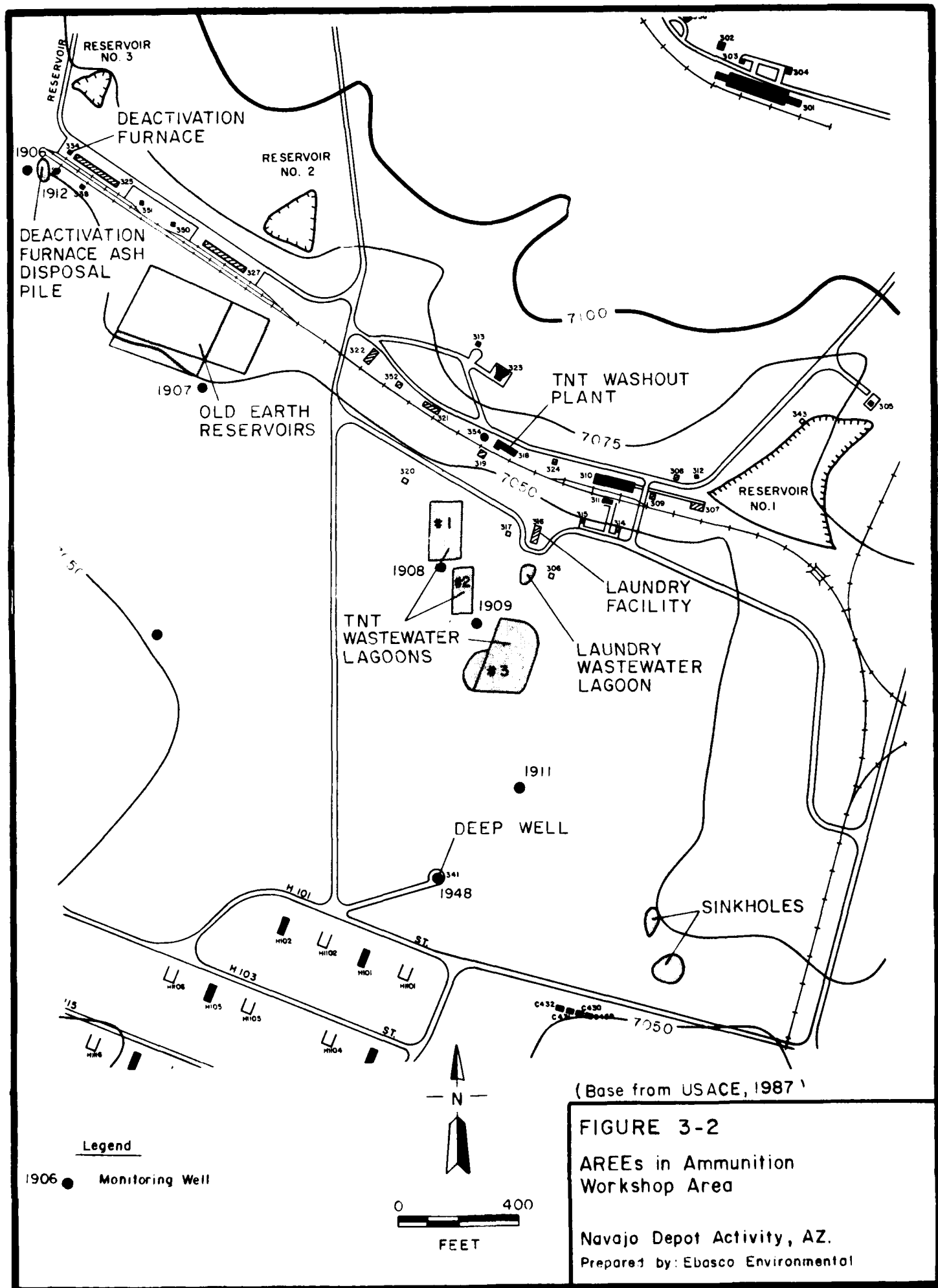
Other former burning-related sites are scattered throughout the Demolition Area. These include the Former Propellant Burning Area (NADA-4), the Former Open Burning Ponds (NADA-6), and three closed OB Areas (NADA-18, 19, 20).

Some disposal activities were noted as occurring in the Demolition Area by USATHAMA (1979), but with no specific site locations attached. In the early 1960s, pallets that were contaminated with mercury as the result of a leaking storage cylinder were burned in this area. Sulfuric, hydrochloric, and chromic acids used to clean empty shell bodies during renovation operations in the Ammunition Workshop Area were also disposed in the Demolition Area.

### 3.2 AMMUNITION WORKSHOPS

#### 3.2.1 TNT Washout and Laundry Facility

The TNT Washout Plant, Building 318, and Laundry Facility, Building 316 (Appendix B, Photograph 10), are located in the Ammunition Workshop Area (Figures 2-2 and 3-2). The existing Washout Facility was constructed upon the former site of Building 575, which was used for the same purpose (Inland Pacific, 1982). Operations at the TNT Washout Buildings involved steam washout, drying, flaking, or pelletizing and packing TNT from bombs and



projectiles. Operations at the Laundry Facility involved cleaning of TNT-contaminated clothing. The TNT Washout Plant discharged TNT-contaminated wastewater through a feeder canal into the Former TNT Wastewater Lagoons (NADA-1). The lagoons permitted the wastewater to percolate/evaporate and allowed the explosive residues (mostly TNT) to settle at the bottom. The TNT Lagoons (Appendix B, Photograph 11) and feeder canal area consist of approximately 1.1 acres of lagoon area, surrounded by two ft embankments (Malcolm Pirnie, 1988). The wastewater lagoons include three TNT lagoons and a laundry lagoon. The lagoons are located proximal to each other south of the TNT Washout Buildings in the Ammunition Workshop Area. TNT Lagoons 1 and 3 were internally engineered with low dikes to enhance evaporation and percolation of the wastewater (USAEHA, 1987). It was noted in a 1940s aerial photo that the only lagoon present and full of liquid was Lagoon 3 (EBASCO, 1989b).

Wastes from the Laundry Facility were discharged to the south into an unlined lagoon. The depths of all four wastewater lagoons vary up to a maximum of 6 ft. The lagoons primarily operated in the late 1940s until 1952, but minor quantities of waste possibly may have been released until 1967 (USAEHA, 1987). Interviews with personnel revealed a discrepancy concerning past operating procedures related to the decontamination of the feeder canal and lagoons. Some interviewees stated that the areas were scraped and the scrapings hauled to the Demolition Area for burning. Others stated that once the ponds dried, they were flash burned on weekends. Others contend that nothing was ever done to decontaminate these areas (USATHAMA, 1979).

A study based on a fluorescein dye test conducted by the U.S. Geological Survey in 1951 concluded that explosives-contaminated wastewater could contaminate groundwater in the deep well via the sinkhole that drains surface water runoff from the lagoons and Ammunition Workshop Area. The former open discharge system was changed to a closed system in January 1953 and virtually eliminated wastewater discharges. Interviews with employees who worked at the washout plant indicate that the lagoons were not used after the plant changed over to a closed system. In the closed system, water from the washout operation in Building 318 flowed through settling tanks, then through tiered filter tanks, and finally into a holding tank in Building 319 (Appendix B, Photograph 12). When the wastewater from the closed system could no longer be recycled, the water from the holding tank was transported in a metal tank to the Demolition Area, where it was hauled to the TNT Retention Ponds (NADA 3) and the Open Burning Trenches (NADA 10) and dumped on piles of dunnage, allowed to dry and, then burned (ESE, 1981). Employees collected and packed TNT recovered from the settling tanks and filters in containers for further use, either as salvaged material or for demolition purposes. Since the volume of water from the washout operation at times exceeded the capacity of the holding tank, excess water periodically drained to a large leaching pond connected to Building 319 by an open ditch (ESE, 1981).

TNT washout operations in Building 318 continued until in 1972. Following this, the equipment was disassembled and decontaminated. Two abandoned "Old Earth Reservoirs" located south of Building S-327, the former East Packing and Crating Building, are identified as "chemically treated ponds." However, according to interviews with former employees, the Santa Fe Railroad built the Old Earth Reservoirs prior to NADA's inception to hold runoff from the springs (Appendix B, Photograph 13). Apparently water was pumped with old steam pumps up to Bellemont Railroad Station. Information obtained from interviews with NADA

employees consistently indicated the reservoirs did not receive wastewater. Wastewater was not generated by activities at Building S-327 (USAEHA, 1987). However, a preliminary study conducted in 1981 by ESE showed results of 1.7 milligrams per kilogram (mg/kg) TNT from a sample collected in the Old Earth Reservoir. Furthermore, subsequent study showed the ponds held acid wastes generated from ordnance renovation activities in Building 322. These wastes included nitric, sulfuric, and possible chromic, phosphoric, and hydrochloric acids (EPA, 1982). The acid wastes from these operations were also reportedly taken to the Demolition Area and burned (USTHAMA, 1979). Visual inspection of the lagoons shows they now support vegetation typical of this area. No evidence of "pink water" or TNT residue was observed in any of the lagoons. Analytical results of the lagoons show TNT detected at concentrations ranging from 0.1, in the TNT Lagoons, to 150 mg/kg, in the feeder canal, in Borings B-9 and B-8, at depths of 0 to 1 and 0 to 1.5, respectively (Malcolm Pirnie, 1989). Analytical results of samples collected from ESE Borings 1930, 1931, and 1934 show TNT concentrations of 4.75 mg/kg, 5.19 mg/kg, and 2.52 mg/kg, respectively. Moreover, lead, barium, iron, manganese, and magnesium were observed above background concentrations (Malcolm Pirnie, 1989).

Malcolm Pirnie (1989) has recommended a no action alternative for remediation of the TNT Lagoons. Based on the analytical results, the low concentrations of TNT identified in the surface soils are not reactive, and the lack of TNT in shallow samples beneath the feeder canal and lagoons further suggest that the TNT encountered has a low potential for migration through the soil column to the groundwater system. Therefore, the existing lagoons, if left intact, do not present an environmental hazard of significance. This alternative was approved by ADEQ, with the understanding that additional groundwater sampling will take place and that if groundwater contamination associated with the TNT Lagoons is found, then other alternatives will be considered (Malcolm Pirnie, 1989). Preliminary results of groundwater sampling conducted in August 1989 by AEHA indicate the lagoons are not causing a groundwater contamination problem (EBASCO, 1989b).

### 3.2.2 Deactivation Furnace and Ash Disposal Pile

#### 3.2.2.1 Deactivation Furnace

The former Deactivation Furnace (Figure 3-2), located in Building 334 (NADA-13) in the Ammunition Workshop area, was used for the demilitarization of small arms ammunition, tracer rounds, primers, detonators, delays, and fuzes (Appendix B, Photograph 14) (Malcolm Pirnie, 1988). The process recovered lead, brass, and steel (Inland Pacific, 1982). The process also produced a residual ash material that was dumped outside the building in a waste pile (Appendix B, Photograph 15). The furnace was torn down in 1989 because it was not cost-effective to upgrade it to meet RCRA Part B Permit standards. Presently, it is in pieces waiting transport off-base.

The building housing the furnace had dimensions of approximately 25 ft by 50 ft. Its floor consisted of native soil and cinders and there was no roof (Malcolm Pirnie, 1988). A review of the design drawings for the Deactivation Furnace also indicate the presence of a sump and drain line extending westerly from the western edge of the furnace footing to an exterior sump (Malcolm Pirnie, 1989). Composite soil samples collected on May 21, 1985, in the vicinity of the Deactivation Furnace and analyzed by EP toxicity tests indicated a concentration of 8.11 parts per million (ppm) of lead and 1.2 µg/g of HMX at the "Conveyor out" area of the Deactivation Furnace; a lead concentration of 30 ppm, HMX of 1.7 µg/g, RDX of 1.6 µg/g

and TNT of 2.3  $\mu\text{g/g}$  at the lead recovery area; and an HMX concentration of 1.1  $\mu\text{g/g}$  at the perimeter of the building (Malcolm Pirnie, 1989). In one sample from Boring B1 at 4 to 5 ft, lead was detected at 239 mg/l, a level exceeding the EP toxicity test for this metal. In the total metal analysis, lead and barium were detected at various depths in three and two borings, respectively. Two borings exceeded the action levels for total petroleum hydrocarbon levels (Malcolm Pirnie, 1989). Soils beneath the Deactivation Furnace building contained diesel fuel contamination, and diesel concentrations ranged from 43mg/kg to 5,550 mg/kg. The diesel appeared to leak from a surface storage facility and an underground service connection to the Deactivation Furnace (Malcolm Pirnie, 1988).

#### 3.2.2.2 Deactivation Furnace Ash Disposal Pile

The Deactivation Furnace Ash Disposal Pile (NADA-14) consists of loosely dumped mounds of ash waste and scattered munitions fragments produced by the Deactivation Furnace, Figure 3-2. The disposal pile, located west of the Deactivation Furnace has an area of approximately 1,800 square ft, with a maximum depth of 4 ft tapering off to zero at the edges. Use of the Ash Disposal Pile continued from the 1960s until the late 1970s (Malcolm Pirnie, 1988). Currently a polyvinyl chloride (PVC) sheeting, held in place by sandbags, covers the ash pile (USAEHA, 1987). The ash pile will undergo closure and be transported to a RCRA landfill in 1990 (EBASCO, 1989b). The ash pile waste is observed extending northerly into the railroad ballast, and west of the access road leading south from the Deactivation Furnace. In a preliminary study of NADA completed in September 1981, results from samples collected at the ash pile contained 1.05 mg/kg of TNT (Malcolm Pirnie, 1989). Moreover, samples collected from the pile showed lead above the EP toxicity test level. Results of a total metals screen showed barium and lead above background levels in samples from two borings. The depth of contamination directly beneath the Ash Disposal Pile is undetermined, but it is not anticipated to extend more than 1.5 ft below the ground surface because samples collected at this depth did not indicate the presence of metals above established limits (Malcolm Pirnie, 1989). Groundwater quality from adjacent Monitoring Well 1912 showed no contamination in samples taken in 1981 and 1984 (USAEHA, 1987).

Malcolm Pirnie recommended a source control remedial action for the Deactivation Furnace and the Deactivation Furnace Ash Disposal Pile. According to that report, the most feasible alternative identified that appeared to be capable of satisfying the alternative development and screening criteria specified in 40 CFR 300, Subpart F, for remedial action selection is removal of the ash waste and contaminated soils and disposal at an EPA-approved hazardous waste landfill. This alternative has been approved by ADEQ and is the most cost effective (Malcolm Pirnie, 1989).

#### 3.2.3 Other Ammunition Workshop Area Buildings

Demilitarization and renovation operations were conducted in all Ammunition Workshop Area buildings until the late 1960s. Table 3-1 lists the buildings located in the Ammunition Workshop Area along with the activities that occurred there and potential contaminants present. Figure 3-2 shows building locations. The operations in the Ammunition Workshop Area consisted of propellant debagging, primer removal, shell disassembly, paint removal, painting, and TNT removal and recovery. The TNT removal and recovery operations were performed in Building 318, which was last used for TNT washout operation in 1972. It was the only building used for this purpose (ESE, 1981). South of Building 318 is Building 319, a former

Table 3-1 Ammunition Workshops Buildings Usage

<u>Building Number</u>	<u>Activity</u>	<u>Potential Contaminants</u>
301	Spray painting, abrasive cleaning, woodworking, depriming cartridge cases, and tracer removal	Paint pigments, heavy metals, and primer residues
307	Renovating shells, including cleaning and derusting, stencilling, and repackaging	Paint pigments, paint, and heavy metals
310	Removing pellets from rifle grenades, renovating shells including removal of powder from shells and painting, punching out of primers, painting, burning out tracers, and demilitarization of WP rounds	Tetryl, double base powder, black powder, paint pigments, and phosphorus
316	Laundering powder uniforms	TNT
318	Washout and recovery of TNT	TNT
321	Debanding projectiles, debugging propellant charges, and painting	Black powder and paint pigments
322	Drying of spray-painted ammunition; degreasing, cleaning, and preparing shells for painting; and spray painting	Alkali, paint pigments, phosphoric and chromic acids, solvents
325	Drawing off lead and other metal components from demilitarization blast furnaces, repackaging shells, disassembly of boosters, spray painting, and disposal of small-arms ammunition	Lead, tetryl, paint pigments, heavy metals, and fly ash
327	Rust removal and spray painting	Metals, paint, and paint pigments
334	Deactivation furnace and disposing of small-arms ammunition	Heavy metals residue
T-510	Disassembling shells	Double Base Powder

Source: USATHAMA, 1979

settling and filtering facility, where the water from the washout operation was run through settling tanks, through tiered filter tanks, and into a holding tank (USATHAMA, 1979).

Through an interview with a NADA employee, it was reported that Building 325 (NADA-34), located adjacent to the Deactivation Furnace, contains approximately twenty-five 55 gallon drums of Deactivation Furnace ash. The drums are scheduled to be included with the Deactivation Furnace closure (EBASCO, 1989b). Activities formerly conducted at Building 325 included drawing off lead and other metal components from demilitarization furnaces, repacking shells, disassembly of boosters, spray painting, and disposal of small arms ammunition (USATHAMA, 1979).

Soil samples collected around the Ammunition Workshop buildings and in the former washout lagoon south of the Ammunition Workshop showed contamination by TNT. Every soil sample collected from these areas contained detectable levels of explosives-related compounds. Levels above the detection limit of 194  $\mu\text{g/kg}$  for TNT, from 808 up to 28,700  $\mu\text{g/kg}$ , were found in the TNT leaching pits, the acid pits, the Deactivation Furnace Ash Disposal Pile, below the ash pile, south and north of the Deactivation Furnace building, and the southwest corner of Building 319 in the Ammunition Workshop Area (ESE, 1981). In the sample containing 28,700  $\mu\text{g/kg}$  of TNT, trinitrobenzene (TNB) was also measured at a concentration of 18,700  $\mu\text{g/kg}$  (Graf, 1984). Previously collected hydrogeologic data indicate that surface and groundwater most probably moved in a southeasterly direction from the Ammunition Workshop Area toward the sinkhole (ESE, 1981). It was concluded that if significant contamination of soils, sediment, surface water, or groundwater existed in this area, deeper aquifers may have been affected by contaminant movement through the sinkhole. Several of the monitoring wells tapping shallow groundwater in the Ammunition Workshop Area contained priority pollutants including toluene, ethylbenzene, cadmium and zinc above the detection level (ESE, 1981). Sulfate was also detected at ten times the background level.

### 3.3 MUNITIONS STORAGE

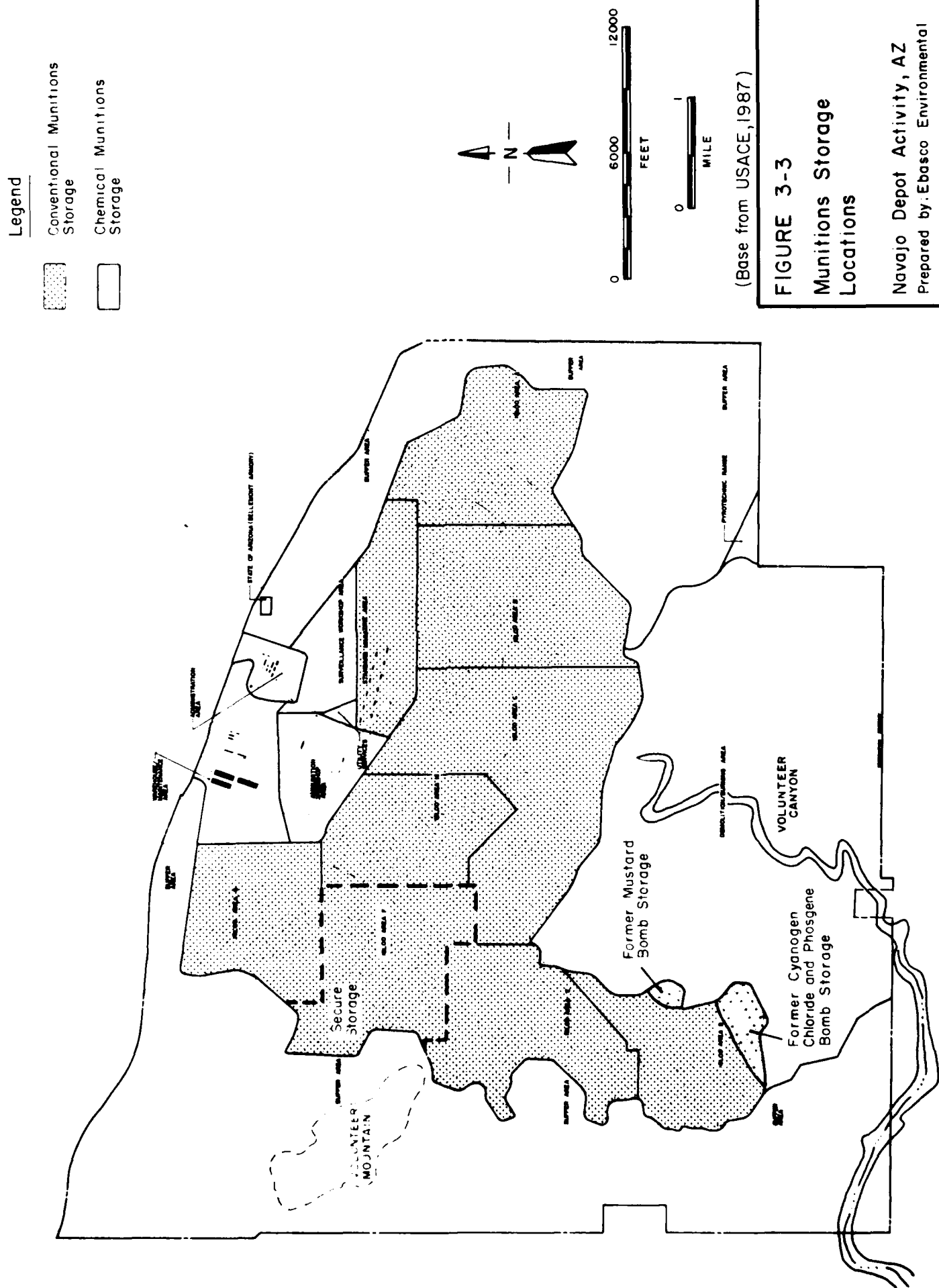
#### 3.3.1 Conventional Munitions

Igloo Areas A through H were built in 1943 shortly after NADA was established (Figures 2-2 and 3-3). The typical igloo construction of reinforced concrete with a soil and grass cover is designed to minimize damage from an explosion of stored munitions. Currently 340 of the 776 igloos on NADA are used for the storage of conventional ordnance and pyrotechnic materials (EBASCO, 1989b). Igloo Area F is fenced and equipped with alarms for the storage of higher security items. The Standard Magazine Area is used for the short-term storage of conventional munitions being moved in and out of the Igloo Areas.

#### 3.3.2 Chemical Agents

Mustard (H)-filled M-78 bombs were stored in the D-200 series igloos from 1945 until 1958, when they were shipped by rail to California for disposal at sea (Figure 3-3). Super tropical bleach powder, a decontaminating material, was also stored in these igloos (USATHAMA, 1979). When emptied, the igloos were not decontaminated.

Beginning in 1945, approximately 20,000 M-78, 40,000 M-79, and 8,000 one thousand pound CK-filled bombs, along with a smaller number of CG-filled bombs, were stored in the D-300 series igloos and open storage sites (USATHAMA, 1979). In the middle 1960s, these



agents were demilitarized by venting in the southern part of the demolition grounds. This demilitarization activity was discussed in Section 3.1.1.

Both the D-200 and D-300 series igloos have been used subsequent to the storage of chemical munitions for other storage including conventional munitions.

### 3.4 MUNITIONS TESTING AND TRAINING

NADA's mission as a reserve supply depot and its use as a National Guard Facility has required past and current munitions surveillance and testing as well as personnel training activities. These activities have been limited to a few areas of NADA. Munitions testing activities are discussed below separately from personnel training activities.

#### 3.4.1 Surveillance Testing

Proof-testing has been a very limited component of NADA munitions testing activities. The only reported material proof-testing conducted at NADA occurred in 1966. This testing involved a modification to a 3.5 inch rocket motor. The rocket motors were fitted with an inert rocket head and tests were conducted with the motor in the captured mode. None of the rockets was reported lost or accidentally launched; all malfunctioning motors were destroyed (USATHAMA, 1979). The location of the proof-testing activities was not reported.





Surveillance testing has comprised the bulk of the munitions testing at NADA. The Surveillance Division of the Directorate of Supply, Ammunition, and Transportation conducts inventories and limited quality control checks throughout assigned operations. Ammunition surveillance personnel reclaim, renovate, preserve, and package ammunition material (EDGE, 1988). Quality control requires certain monitoring and testing procedures, which have generally taken place in three areas: the former Chemical Laboratory, the Pyrotechnic Range, and the Surveillance Workshop Area (Figure 3-4). These three sites are discussed below.

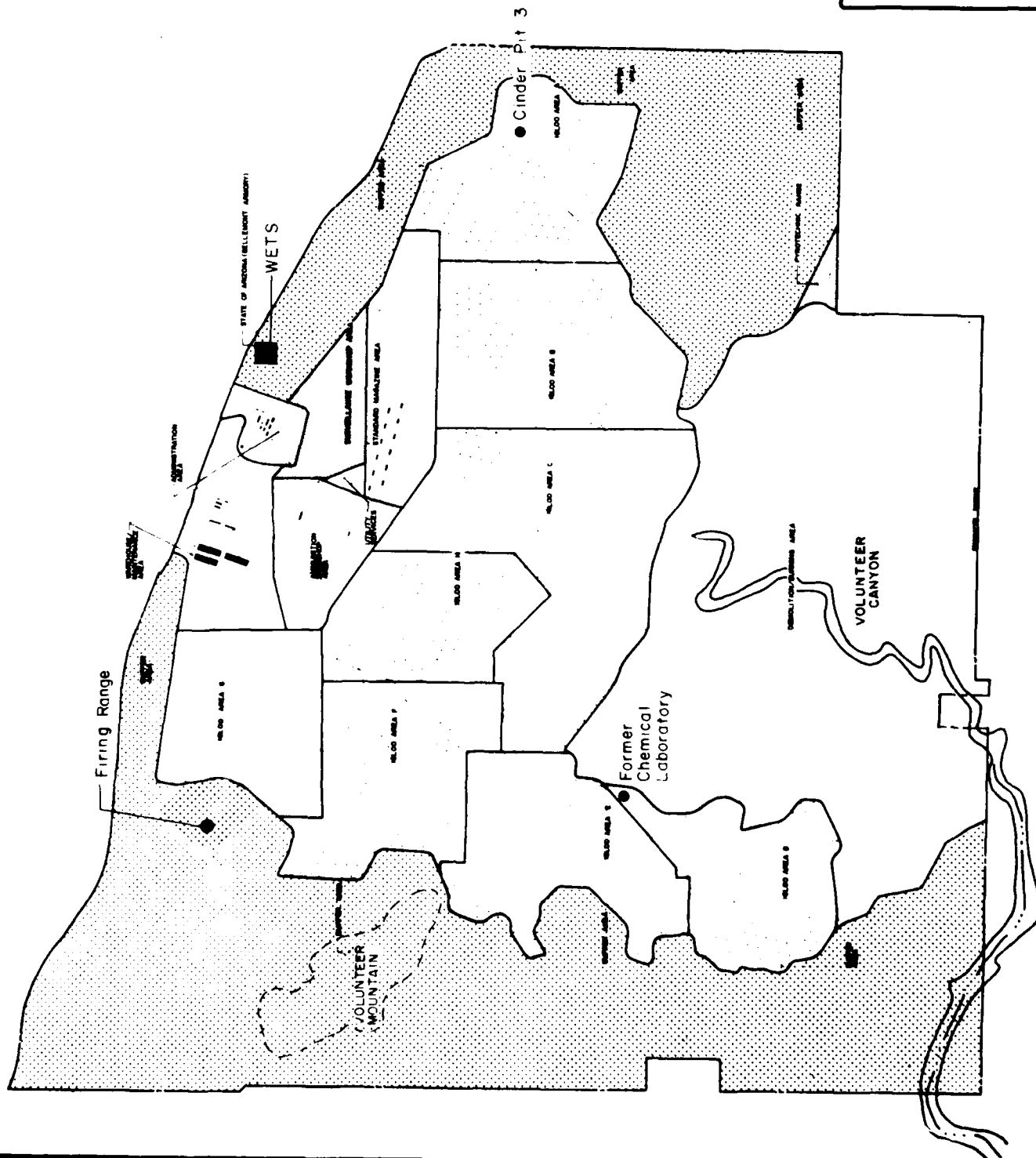
The former Chemical Laboratory (Building 460), located in Igloo Area D and identified as NADA-2 (USAEHA, 1987), was used for sampling, testing, and surveillance of chemical munitions, formerly stored in Igloo Area D. The building was used for servicing and testing CK- and CG-filled bombs, but tests on mustard (H)-filled bombs were reportedly not conducted there (USATHAMA, 1979). Testing involved simple procedures, such as weighing small samples (2 to 3 milliliters (ml)) of CK and CG, allowing them to evaporate, then weighing the residues. Decontamination was accomplished by flushing with water and exposure to air. Decontamination wastewater was eliminated by pouring it on the ground in an area adjacent to the west side of the laboratory (USATHAMA, 1979) or discharging it via a drain pipe to an area west of the building (USAEHA, 1987). Residues from this operation were soluble, inorganic salts (USATHAMA, 1979).

Maintenance operations were performed on CK- and CG-filled bombs stored in the D-300 series igloos and "Y" sites. These included changing needle valves on CK- and CG-filled bombs and adding stabilizer to CK bombs (Inland Pacific, 1982). It is not known if these activities were performed at the former Chemical Laboratory. Additional discussion of CK- and CG-filled munitions occurs in Sections 3.1.1 and 3.3.2.

Building 460 was declared excess in 1970 and was razed and removed by a contractor. Minor remaining debris was then hauled to the Demolition Area where it was burned and buried.

# Legend

-  Munitions Testing
-  Buffer Areas
-  WETS
-  Other Training/Test Sites



(Base from USACE, 1987)

FIGURE 3-4

## Munitions Testing and Training Areas

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

The concrete slab of the former building remains intact, as do a tile discharge pipe extending westerly from the slab to a shallow furrow in the adjacent woods, a sump adjacent to the slab, and the remains of two small, unidentified structures east and west of the slab (Figure 3-5) (USAEHA, 1987). A water sample collected from the sump showed no contamination (ESE, 1981). Because the laboratory lacked an identified water source, the sump may in fact have been a water cistern that stored water trucked from the supply system in the Administration Area, rather than a waste-related feature. The remains of the small structure west of the slab resemble those of an outdoor latrine (EBASCO, 1989b).

The Pyrotechnic Range, located in the southeast part of NADA between the Demolition Area and the east Buffer Area, was used for the surveillance testing of controlled quantities of conventional munitions. No chemical munitions (CG-, CK-, or mustard (H)-filled bombs) were tested. It has been indicated that the area does not contain any unexploded ordnance or explosives contamination based on previous interviews conducted with personnel familiar with operations at the time of use. All items that malfunctioned were either recovered, examined, and sent to the Demolition Area for destruction, or destroyed in place if deemed too hazardous to move. Some of the items that underwent surveillance testing included small arms ammunition, rocket motors, and grenades (both hand-thrown and rifle-fired) filled with HE, HC, colored smoke, WP, PWP, CN, CS, and thermite (USATHAMA, 1979).

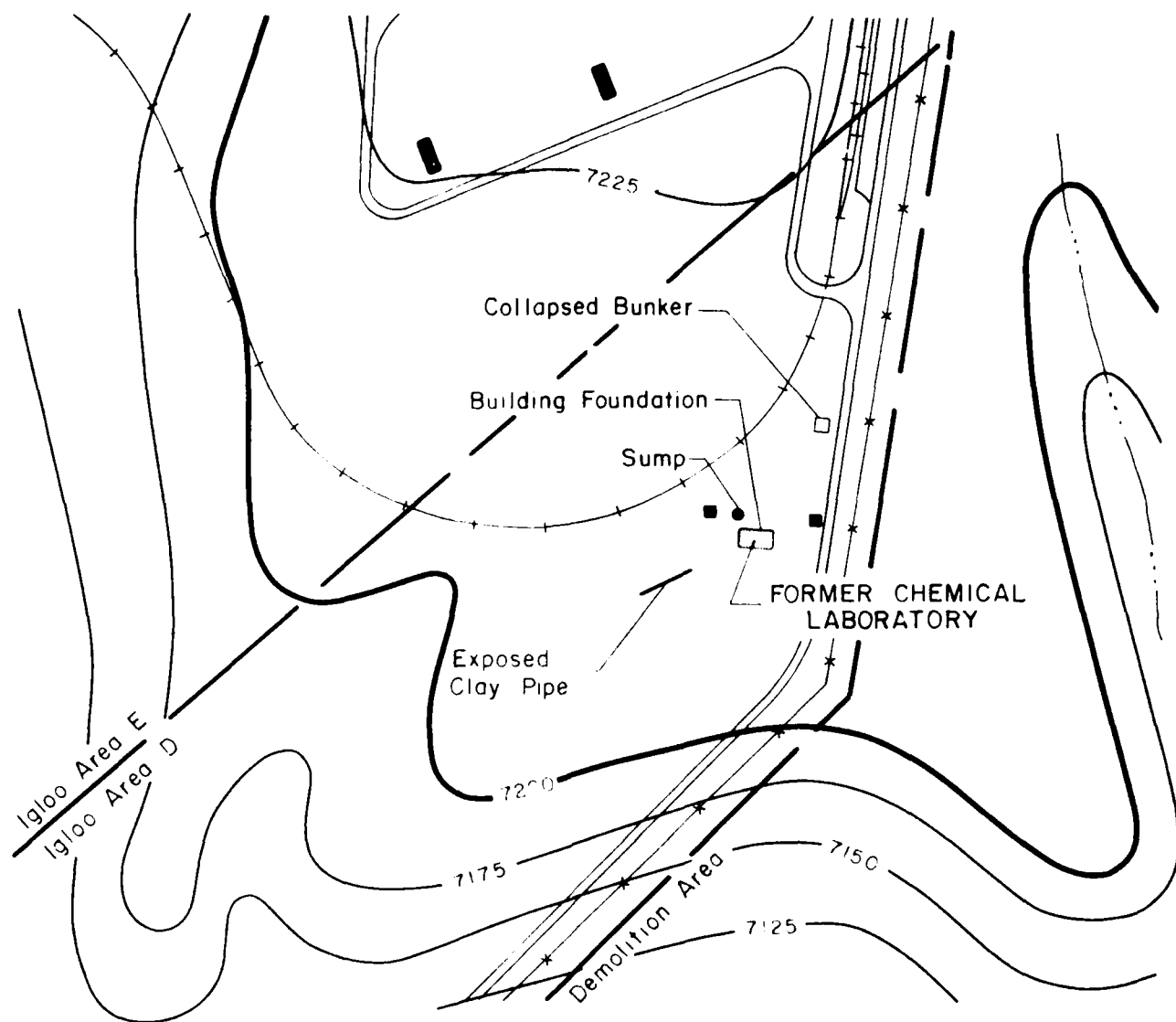
The Surveillance Workshop Area's location in the north-central part of NADA east of the Ammunition Workshop Area is governed by quantity distance criteria (USATHAMA, 1979). This area, which contains just one building (Building 331) on its western end, was used for surveillance of controlled quantities of propellants, explosives, fuzes, and primers, under varying controlled climatic conditions. Upon completion of these tests, the items were taken to the Demolition Area for destruction (USATHAMA, 1979). It has not been reported how much of the testing activities took place in Building 331 and how much, if any, took place outdoors in the remaining open space in the area.

#### 3.4.2 Training Activities

All areas of the Depot have previously been and continue to be utilized by the US Army and the ANG for training purposes. Training activities include training exercises, weapons firing, troop maneuvers and bivouacs, and heavy equipment operation. Many training activities are restricted to the perimeter portions of NADA away from Munitions Workshop, Demolition, and Storage Areas, whereas ordnance units train primarily in Ammunition Storage Areas. Specific training activities and locations are discussed below.

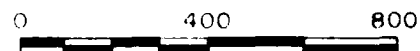
The Buffer Areas accommodate a large proportion of the training activities. The ANG uses the former hospital area located east of the Administration Area. These facilities, together with the newly constructed ones on the adjoining state-owned ANG Bellemont Armory property, comprise the WETS, and house administrative offices, classrooms, and billets for weekend training programs and annual summer encampments. Plans call for the older structures to eventually be razed to provide parking for the newer facilities (ANG, 1988). The former Hospital is discussed further in Section 3.5.5.

The Buffer Areas continue to be used for maneuvers, bivouacs, and Ammunition Specialist training exercises for Reserve Component troops. Small arms blank ammunition and hand grenades (colored smoke-, HC-, CN- and CS-filled) are used during these exercises. The



Legend

- 7150 Elevation ft mean sea level
- Fence
- Road



(After USAEHA, 1987)

FIGURE 3-5

Former Chemical Laboratory Site

Navajo Depot Activity, AZ

Prepared by Ebasco Environmental

involved organizations police the area upon completion of the exercises. There have been reports of malfunctioning training munitions in the Buffer Area. Latrines are not dug in the Buffer Area during bivouac or training exercises, as portable chemical toilets are used (USATHAMA, 1979).

An ANG heavy equipment unit has done maintenance on Depot roads as part of training exercises. Materials for road maintenance were obtained from a quarrying operation in the southeast part of Igloo Area C, opposite a site that had been used as a demolition area prior to 1950 (USATHAMA, 1979). For training purposes, the ANG has also established an asphalt plant in the Warehouse Area to produce asphalt paving materials. This plant is discussed further in Section 3.5.4.

A rifle and pistol firing range has been constructed by the ANG in the Buffer Area in the northwest part of NADA (Figure 3-4). In addition to the ANG, the NADA Security Police and the Arizona Highway Patrol use the range for qualification and weapon proficiency firing. The range is cut into a bank of volcanic cinders at the base of a 600 ft mountain, which serves as a backstop (USATHAMA, 1979).

A small arms firing range was formerly used in Cinder Pit 3 in Igloo Area A (EBASCO, 1989b). Cinder Pit 3, also the site of past landfill activities, has been identified as NADA-16 (USAEHA, 1987). Cinder Pit 3 is discussed further in Section 3.7.1.2.

Chemical, biological, and radiological (CBR) team training was conducted at some time in the past. The training involved hiding small 3/4 inch long tubes with cobalt-60 and plutonium and using instrumentation to locate the radiological sources (EBASCO, 1989b). The locale for this training was not reported. The CBR training is also discussed in Section 3.6.3.

### 3.5 OPERATIONS FACILITIES

Operations facilities include various nonammunition mission-related buildings and sites. Locations of these facilities are shown in Figure 3-6. Facilities located within the Administration Area are depicted in Figure 3-7.

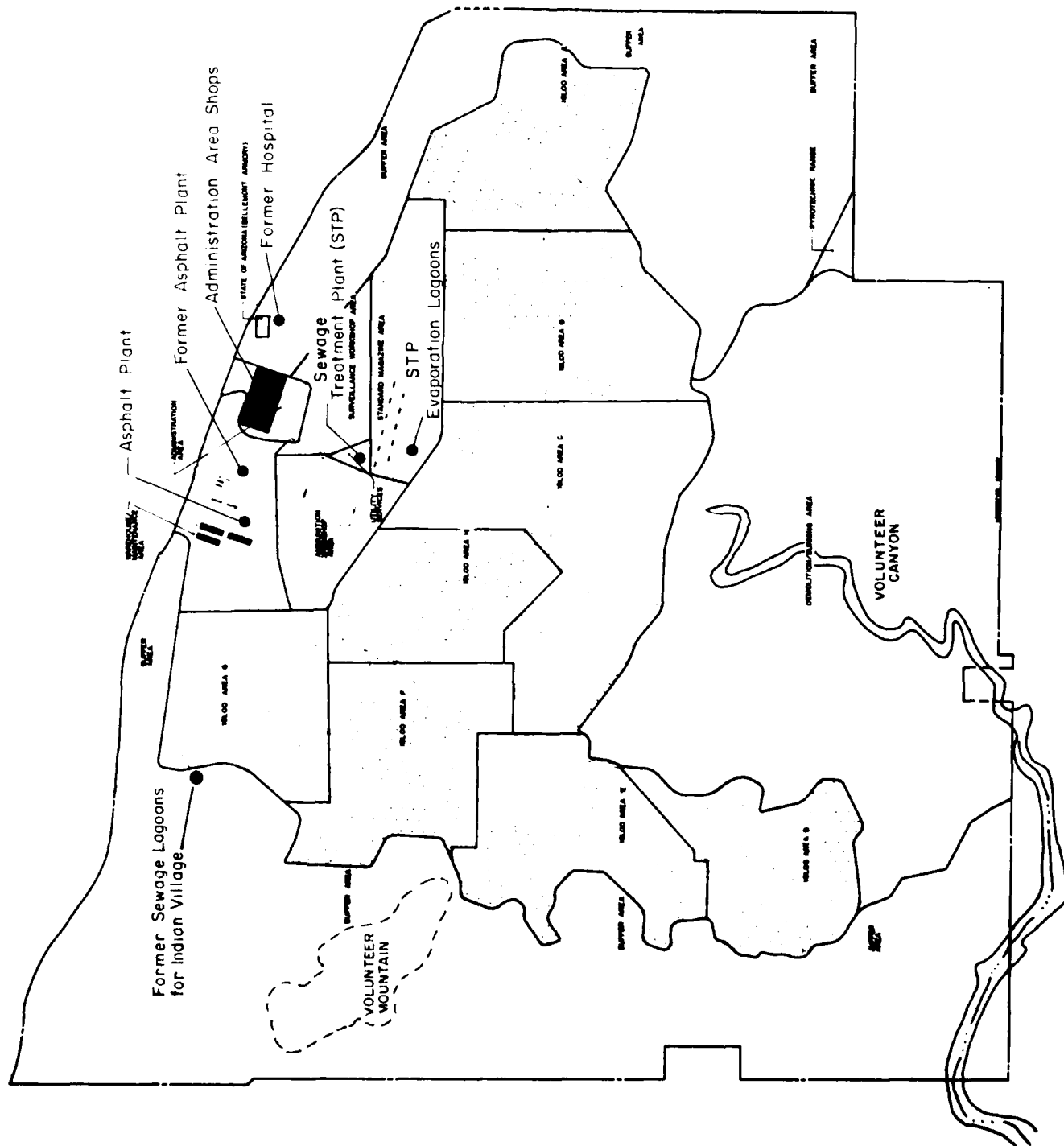
#### 3.5.1 Vehicle and Locomotive Shops

##### 3.5.1.1 Vehicle Maintenance Shop (Building 23)

Automotive repair and maintenance is performed in Building 23 on vehicles up to the size of five to seven ton trucks (Figure 3-7). Current operations include engine and transmission rebuilding, as well as general vehicle maintenance and service. Waste products such as stripping and degreasing solvents, oils and other vehicle fluids, and battery acid are collected in work pans at each work station and accumulated in separate 55-gallon drums within the building. Spill containment for storage of drums within this building may be inadequate. After the drums are full, the drums are removed and stored in an unbermed, gravel-covered, fenced, and locked Open Air Storage Area west of Building 17. These practices conform with the Spill Prevention, Control, and Countermeasure Plan (SPCCP) (NADA, 1988c). The approximately 40 to 50 drums are strapped onto pallets waiting for transport off-base for recycling or disposal. The drums and pallets are separated by material type and are labeled with material type and drum number. Full drums are not stored for longer than 90 days before removal (EBASCO, 1989b).

# Legend

● Operations Facilities



(Base from USACE, 1987)

FIGURE 3-6

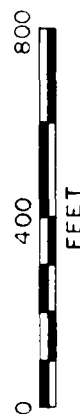
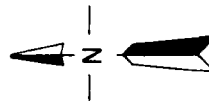
Operations Facilities AREEs

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

Bldg.

Title

18	PCB Storage Building
23	Vehicle Maintenance Shop-Motorpool
24	Heavy Equipment Shop
27	Underground Fuel Tanks and Fuel Pumps
29	Electrician Shop
30	Roundhouse / Locomotive Maintenance Shop
31	Former Diesel Fuel Storage Tank
33	Vehicle Storage and Winter Troop Lodging
34	Carpentry Shop
35	Paint Shop
36	Paint-Related Materials Storage
37	Incinerator



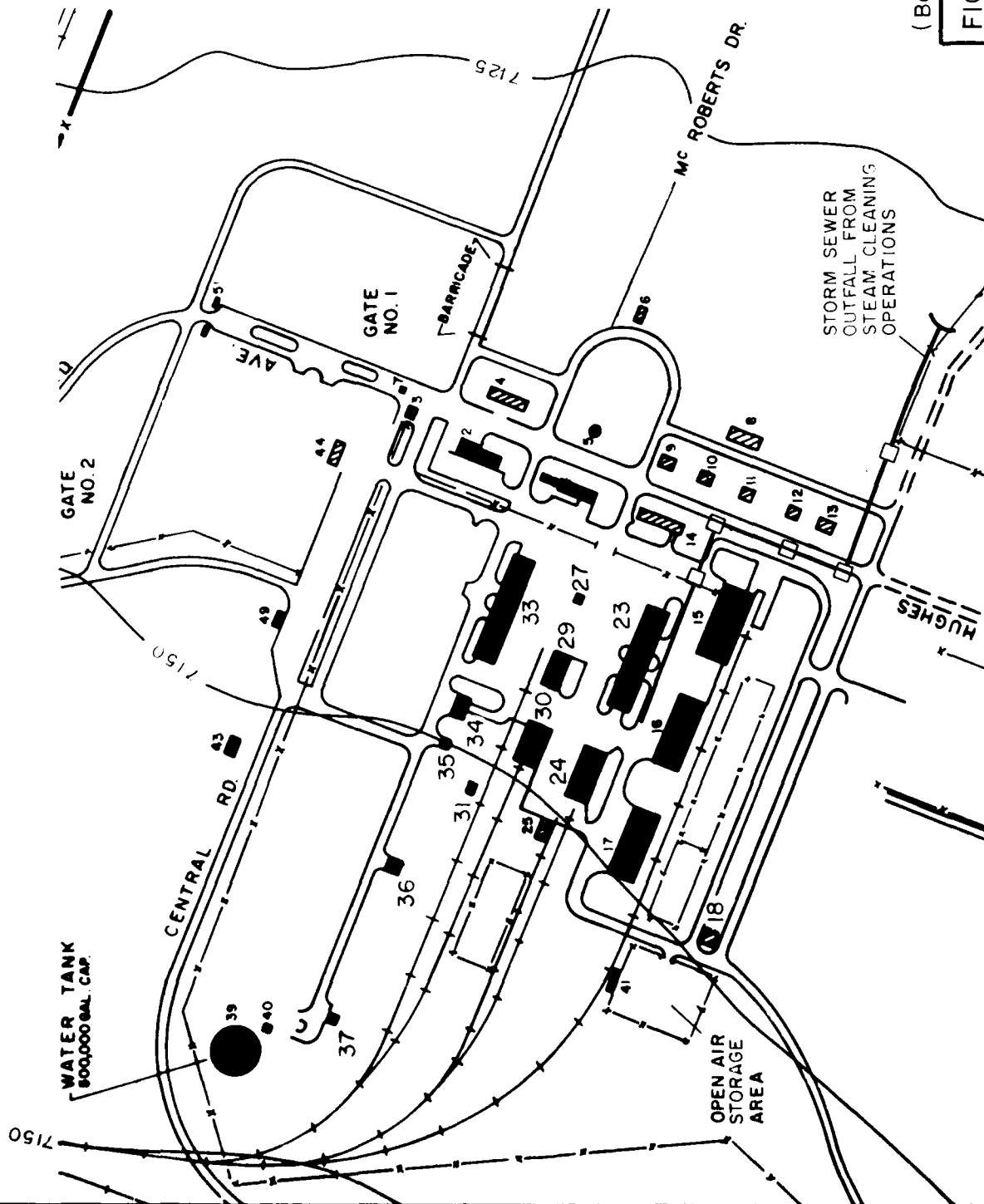
(Base from USACE, 1987)

FIGURE 3-7

Operations Facilities AREEs in Administration Area

Navajo Depot Activity, AZ

Prepared by: Ebasco Environmental



An outdoor wash bay for vehicle steam cleaning is located adjacent to Building 23. Washwater passes through a floor drain to an oil/water separator and runs into the Storm Sewer Outfall (NADA-30). There is no permit for discharge from the Storm Sewer Outfall for this steam cleaning operation. This bay has been used for parts and engine cleaning as well as general vehicle cleaning. The stripping and degreasing solvents as well as other vehicle fluids from leakage could be included in this outflow.

Past activities have consistently included containerizing all waste fluids from vehicle maintenance in separate drums. The only departure from this was the former handling of waste oils (motor oil, transmission fluid, lubrication oil) that were not removed by vendors. Rather, they were combined from the individual drums into a large tank mounted on a truck bed. This fluid was then either used for dust suppression on the numerous dirt roads throughout the Depot or released in the cinder pits or the Former Sanitary Landfill. No information on the proportional amounts of these disposal activities is available. Presently the waste oils are containerized and disposed by Defense Reutilization and Marketing Office (DRMO) after storage in the Open Air Storage Area as discussed in Section 3.6.5.

Floor stains from vehicle fluid leakage and spillage were evident in the building. PCBs were formerly used as a component of hydraulic fluids and may be present from leak or spill incidents.

Spent batteries from vehicle maintenance operations are stored in Building 55 while awaiting shipment to DRMO. The batteries are not drained for storage, so are filled with battery acid. No visible evidence of spills at this building were noted by EBASCO investigators during the site visit. During an interview, a former employee reported that at one time battery acid was dumped on the ground outside Building 23 (EBASCO, 1989b).

Other vehicle maintenance shops include one that was operated by the ANG in Building 216, east of the GSA Warehouses, for 4 to 5 years in the early 1980s. This shop was referred to as the Organizational Maintenance Shop. It has the potential for past releases of vehicle fluids, but little information is available on this former shop. The current ANG facility, called the Unit Maintenance Facility, is located in Building 601 north of and across the street from the former Hospital. Material and fluids handling at this location conform to the SPCCP (NADA, 1988c), but there could be a potential for leakage and spillage.

#### 3.5.1.2 Heavy Equipment Storage (Building 24)

Building 24 houses heavy equipment such as bulldozers, graders, etc. No known maintenance activities such as fluid removal and exchange occurred in this building. Minor mechanical adjustments were performed on the blades and other parts, but any major work was performed in Building 23. Some floor stains caused by equipment fluid leakage were evident on the concrete. There appears to have been an attempt to clean up the spills as they occurred (EBASCO, 1989b).

#### 3.5.1.3 Roundhouse/Locomotive Maintenance Shop (Building 30)

Building 30 contains the Locomotive Maintenance Shops. Current operations include general locomotive maintenance and servicing. Waste products from these operations such as stripping and degreasing solvents, oils, and other vehicle fluids, and battery acid are collected in work pans at each work station and accumulated in separate 55-gallon drums within the building. Spill containment for storage of drums within this building may be inadequate. After the drums are full, the drums are removed and stored in an unbermed, gravel-covered, fenced, and locked Open Air Storage Area west of Building 17. Full drums are not stored for longer than 90 days before removal. These practices conform with the SPCCP (NADA, 1988c).

It is suspected wastes were historically handled similarly to Vehicle Maintenance Shop wastes. Past activities generally conformed with current waste disposal practices, except for the former use of the waste oils as dust suppressants on the dirt roads throughout the depot, a practice now discontinued. Engine parts cleaning operations could have potentially allowed waste fluids to run into the storm drain system. Staining from fluid leakage and spillage was observed on the floor area and extensively in the mechanic's pit.

#### 3.5.1.4 Vehicle Storage and Winter Troop Lodging (Building 33)

Building 33 is currently used for vehicle storage (i.e., pickup trucks, cars) and troop lodging and drill practice during the winter months. No maintenance operations were performed in this building currently or in the past. Some minor floor staining from vehicle leakage is evident.

#### 3.5.2 Paint Shop and Paints-Related Materials Storage (Buildings 35 and 36)

Buildings 35 and 36 correspond to the Paint Shop and Paint-Related Material Storage, respectively. Current operations include stripping, painting, and finishing of wooden structures, signs, and other various objects produced from the carpentry shop. Paint-related material is obtained from the Paint-Related Material Storage building and is used in the Paint Shop, which has a ventilation system that vents the fumes to the atmosphere. Empty cans and excess material are containerized in 55-gallon drums. After the drums are full, the drums are removed and stored in an unbermed, gravel-covered, fenced, and locked Open Air Storage Area west of Building 17. Full drums are not stored for more than 90 days. Both Buildings 35 and 36 contain cement berms around the perimeter of the cement pads on which they rest, and the individual types of paint-related material are stored separately. These practices conform with the SPCCP (NADA, 1988c). There was no evidence of stains on the floor (EBASCO, 1989b).

#### 3.5.3 Wastewater Treatment

Domestic wastewaters from the administration, industrial, and Wherry housing areas are treated at the Depot's Sewage Treatment Plant (STP) located in the Surveillance Workshop Area (Figure 3-6). This facility was constructed in 1943 and consists of a bar screen, a circular primary clarifier, a rock-medium trickling filter, a secondary clarifier, and two lagoons (NADA-23) that are connected in a series by an overflow pipe. The lagoons are 200 ft by 400 ft (61 m by 122 m) holding/evaporation ponds (Appendix B, Photograph 17). Ponds 1 and 2 are lined with approximately 12 inches (30 cm) of clay with cinders on top. The STP also has sludge handling/treatment facilities that include a pumphouse, a heated anaerobic digester, and sludge drying beds (Appendix B, Photograph 16) (NADA-22). Digested sludge is pumped from the anaerobic digester to one of the two drying beds. After drying, the sludge

is taken to a disposal site located south of Standard Magazine J10 and spread on the ground. It was previously taken to the Former Sanitary Landfill located east of the Standard Magazine Area. Design capacity for the STP is approximately 70,000 gallons per day (270,000 liters per day). The facility does not chlorinate the effluent. No information is available regarding the biochemical oxygen demand or removal percentages of suspended solids from plant operations. There is a potential for sanitary sewer pipe leakage due to the advanced age of these pipes.

Prior to the construction of the first evaporation lagoon south of the Standard Magazine Area in 1975, effluent from the STP was discharged to a dry creek tributary of Volunteer Canyon. This has been the traditional site for disposal of industrial, domestic, and storm drainage on the installation. NADA formerly required an Environmental Protection Agency permit (NPDES Permit No. AZ0110353) to operate its STP, due to discharges of effluent into the canyon. This situation continued even after the first lagoon was built. However, after the second evaporation lagoon was dug in late 1975 to catch the overflow from the first, the NPDES permit was no longer required by EPA since the effluent was allowed to evaporate which eliminates discharge (USATHAMA, 1979).

An inactive Imhoff Tank is located northeast of Igloo Area G. The facility provided filtration of domestic sewage wastewater generated in the former nearby Indian Village. Three Former Sewage Lagoons (NADA-33) (Figure 3-6) consisting of shallow, unlined ponds were used to hold effluent from the Imhoff tank, as well as untreated sewage from the Indian Village.

#### 3.5.4 Asphalt Plants

The Old Asphalt Plant was located in the southeast Warehouse Area (Building S-207) (Appendix B, Photograph 19). The plant was operated by NADA and used to surface NADA roads. The plant had a coal-fired heater to make hot oil for asphalt production which was reported to have been mixed on the ground. The plant was built at the same time that NADA was constructed (EBASCO, 1989b).

The New Asphaltic Concrete Batch Plant is a mobile facility located on the concrete pad west of Building 223 (Appendix B, Photograph 18). This plant has a diesel-fired asphalt heater and a rotary-kiln drier with a 500-gallon aboveground diesel tank and aboveground piping. The plant is owned by the ANG and is operated for approximately two weeks per year.

#### 3.5.5 Former Hospital

The former Hospital is located in Building 101 across from the new ANG maintenance shops. The building is no longer used as a hospital. ANG utilizes part of the building for training; the morgue is now the current location of the laundry facilities; and part was converted to WETS housing. Biological waste was generated and solvents, as well as heavy metals including mercury for dental work and film developing, were likely used at the facility. Records and observations indicate that medical wastes were disposed in the Former Sanitary Landfill area east of the Standard Magazine Area. Medical waste disposal in the Landfill is discussed further in Section 3.7.1.

### 3.6 HAZARDOUS MATERIALS STORAGE

Previous sections have identified some hazardous materials associated with specific activities or operations. This section discusses where other hazardous materials have been or are being stored at NADA. Figure 3-8 illustrates the location of storage facilities identified in the following discussions.

#### 3.6.1 Mercury

GSA (now DLA) mercury stores were housed in Building 231 or 233 in the Warehouse Area before being moved to the Igloo Area in 1960. The mercury warehouse collapsed in a snowstorm in 1967, and the superstructure was subsequently removed. In 1979, there were traces of mercury visible in the cracked foundation of the former warehouse (USATHAMA, 1979). This warehouse pad was not sampled by ESE in their 1981 study because investigators could not visually locate any spill sites (EPA, 1982).

Mercury is currently stored in Igloos H111 and B121. Base personnel indicate that a contract has been let to ship stored mercury from NADA over the next year (EBASCO, 1989b). Spilled mercury has been found in H111, but the lack of any continuing problem suggests the spill may have occurred during the initial relocation of mercury stores. Pallets contaminated with mercury by a leaking storage cylinder were reported to have been burned in an unspecified location in the Demolition Area (USATHAMA, 1979) and are discussed further in Section 3.1.2.

#### 3.6.2 Pesticides

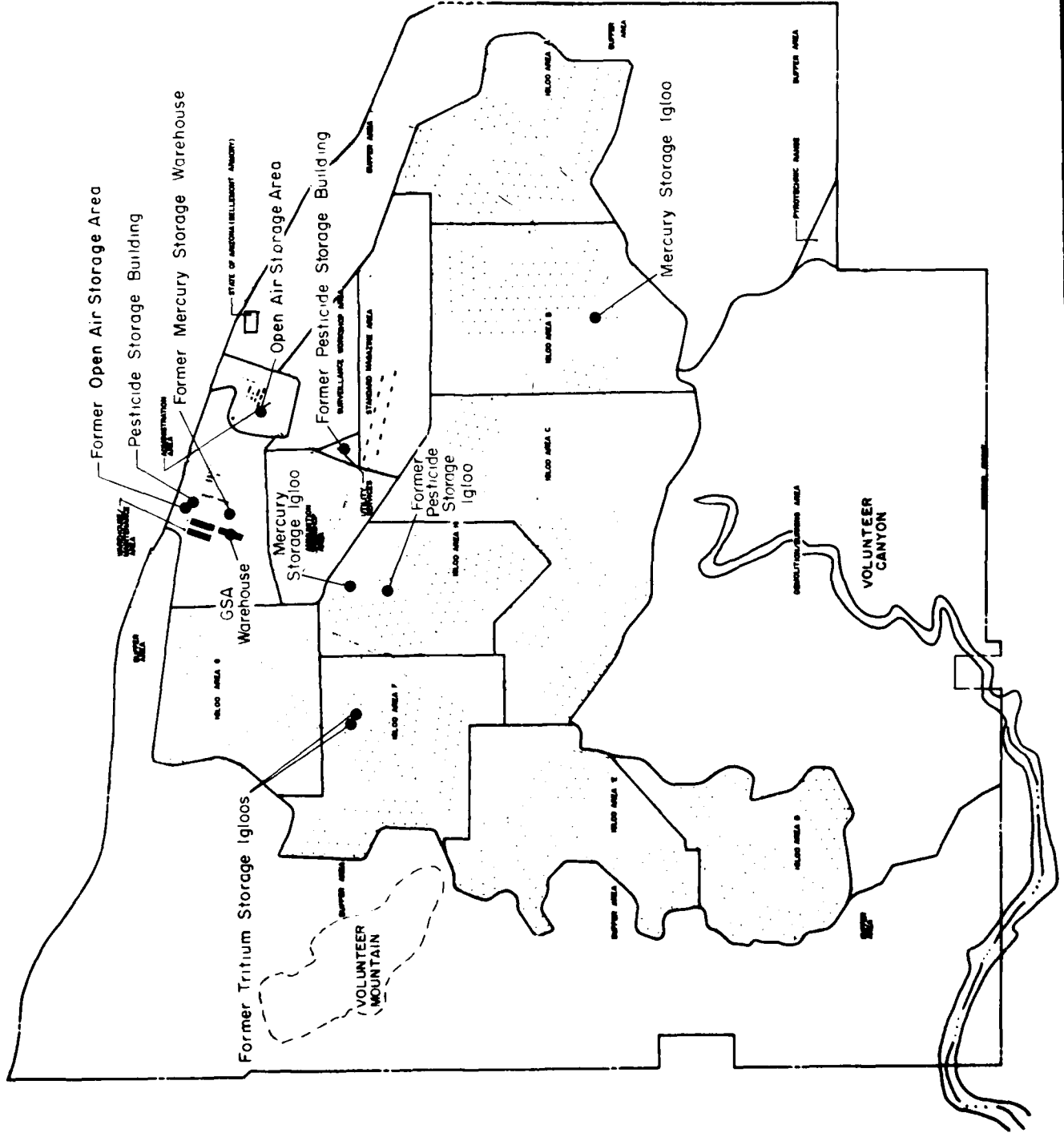
Igloo H118, formerly used for the storage of waste pesticides, was previously identified as NADA-21 (USAEHA, 1987). Some bagged materials stored in this structure got wet because of a leak. A worker entering the igloo was reported to have been nearly overcome by fumes (EBASCO, 1989b). No other incidents of this type have been reported. Waste materials in Igloo H118 were overpacked in drums and shipped to the DRMO at Luke Air Force Base Annex in August 1988. The Uniform Hazardous Waste Manifests (NADA, 1988d) list the following pesticides in this shipment: 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), 2,4-dichlorophenoxyacetic acid (2,4-D), dichlorodiphenyltrichloroethane (DDT), and pentachlorophenol (Kenetrol weed killer). Igloo H118 is now empty, but there has been no closure or decontamination of the structure.

The former Pesticide Storage Facility for NADA was Building 335 next to the Sewage Treatment Plant (Appendix B, Photograph 20). This is a small wooden structure with a wooden floor, a metal roof, and no spill containment features. In 1979 it was noted that the building was inadequate in size for the materials stored there and that some of the larger containers were outside because the lack of space precluded safe handling. It was also noted that outside pesticide mixing occurred at Building 331 (USATHAMA, 1979). In September 1985, a shipment of waste pesticides from Building 335 to Chemical Waste Management of Phoenix, AZ, included dalapon, diazinon, lead arsenate, calcium cyanide, chlordane, lindane, methyl bromide, and malathion (NADA, 1988d). Pesticide stocks were moved from Building 335 to Building 244 in September, 1989. A project for closure of Building 335 has been proposed for 1991 in the Environmental Pollution Prevention, Control, and Abatement Report (1383 Report) (NADA, 1989a), but funding for the project is uncertain.

The current pesticide storage facility, Building 244, is in the northern part of the Warehouse Area. Table 3-2 lists the pesticide inventory for Building 244 as specified in the Pest

# Legend

- Hazardous Materials Storage Sites



(Base from USACE, 1987)

FIGURE 3-8

## Hazardous Materials Storage Sites

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

Table 3-2 Pesticide Inventory for Building 244

Rodenticide Bait - Pesticide (Tarla Dipas)	5 plastic jars, 5 lb each
Insect Aerosol Cans - Insecticide (Synergized Pyrethrums)	130 aerosol cans, 12 ounces (oz) each
Insect Repellent - Insecticide (N,N Diethylmeta-tolumide)	4 boxes, 9 lb total 384 boxes, 2 oz each
Tekhae Hp-D Larvicide, B.T. - Insecticide	1 plastic container, 5 gallons (gal)
Herbicide 2, 4-D - Herbicide (Dichlorophenoxyacetic acid)	5 gal can, 1/4 full
Gopha Rid - Pesticide (Zinc Phosphide)	12 plastic containers
Chemstar (type S Lime)	2 bags, 50 lb each
Roundup - Herbicide (Glyphosate)	4 plastic containers, 1 gal each
Ureabor - Herbicide	6 bags, 50 lb each

Source: NADA, 1989c

Management Plan for NADA (NADA, 1989c). This building is proposed for improvements in 1990 pending availability of funds (NADA, 1989a). These include the installation of power, water, spill control, and firewalls to meet Army storage standards and requirements as specified in Technical Information Memorandum No. 17 (Armed Forces Pest Management Board, 1983).

### 3.6.3 Radioactive Materials

Minute quantities of cobalt-60 and plutonium were previously used at NADA as low-level radiological sources for CBR team training and for calibration purposes. These sources were transferred to Las Vegas in 1968 (USATHAMA, 1979). No records were found of formal decontamination, monitoring, or certification efforts.

On September 29, 1979, NADA received a shipment of radioactive tritium for temporary storage. The governor of Arizona had ordered the tritium to be seized from the American Atomics Corporation in Tucson because of safety concerns. The tritium was stored in Igloos F306 and F307 until July 31, 1980, when it was shipped by the Department of Energy to the Mound Facility in Miamisburg, Ohio (U.S. Army, 1980).

Water samples from around the installation and contamination smear samples from the two buildings were taken prior to receipt of the shipment to establish background radiation levels. Soil, water, and contamination smear samples taken after the shipment left were used to establish that all radiological materials and residual hazards were removed and to certify the area as safe for unrestricted use (U.S. Army, 1980).

### 3.6.4 GSA Warehouses

Buildings 239-241 in the Warehouse Area of NADA have been used since construction in 1953 to store strategic materials for the GSA, and, later, for the DLA when it took over this storage mission. Building 240 is currently used to store tannin and was formerly used to store asbestos. Interviews indicate that uncontained tannin dust and asbestos fibers are readily visible inside this structure. The rupture of a water main in Building 240 has potentially washed some of these substances from the warehouse to surrounding soil (EBASCO, 1989b).

### 3.6.5 Open Air Storage Areas

The Open Air Storage Area is an unbermed, unpaved fenced area in the southwest corner of the Administration Area building complex (Appendix B, Photograph 21). This site serves as a storage area for excess equipment and for materials awaiting processing through DRMO. As discussed in Section 3.5, this area receives drummed wastes including oils, fuels, antifreeze, paints, and thinners from shops in the Administration Area. Spill containment may be inadequate for drums stored at this site. Hazardous wastes are not stored here for more than 90 days, so the site does not require RCRA permit. A 300-gallon tank for the collection of motor oils and hydraulic fluids transported from the vehicle maintenance area was formerly located in this yard. This waste oil tank was identified as NADA-28 (USAEHA, 1987).

The former Open Air Storage Area is next to the current pesticide storage building, Building 244, in the Warehouse Area (Appendix B, Photograph 22). This unpaved site is still littered with drums although it is no longer actively used as a transfer point for equipment and materials from current operations. Previous storage included the types of materials discussed above for the present Open Air Storage Area.

### 3.7 SOLID WASTE DISPOSAL

This section includes solid waste disposal sites that have not been discussed in previous sections with other Depot facilities and operations. The sites are grouped by disposal method. The following discussion covers landfills and burial sites, surface waste piles, and the Administration Area incinerator. Figure 3-9 illustrates the locations of these solid waste disposal areas.

#### 3.7.1 Landfills and Burial Sites

##### 3.7.1.1 Former Sanitary Landfill

The Former Sanitary Landfill, (NADA-17) in the eastern part of the Standard Magazine Area, received trash and garbage from NADA activities from the 1940s to 1966 (USAEHA, 1987). Since that time, solid waste has been hauled off-site to the City of Flagstaff municipal landfill by a contractor. This site apparently received many types of waste including motor oil, sewage sludge, paint cans, and medical waste. Wastes were placed in trenches and generally burned before being covered with a cinder material. Some wastes were not burned prior to burial (EBASCO, 1989b).

The Former Sanitary Landfill occupies approximately four acres on the side slope of a small valley with a dry drainage at the bottom (Figure 3-10). According to the topography, the landfill probably has two lifts (Appendix B, Photograph 23). The lower lift extends from the valley bank to the dry stream bed. The upper lift covers half of the lower and terminates in a 12 ft slipface (Appendix B, Photograph 24). A minor amount of trash and medical items can be seen at the top of the slipface. The bottom is littered with waste metal, roofing material, logs, rocks, and soil (USAEHA, 1987; EBASCO, 1989b).

A soil sample collected adjacent to the landfill showed TNT and TNB to be present along with traces of fluoranthene, naphthalene, phenanthrene, and pyrene (ESE, 1981). Two groundwater monitoring wells were installed and are assumed to be downgradient from the landfill (Figure 3-10). Zinc and nutrient parameters were detected in both wells, with concentrations substantially higher in the well closest to the landfill (ESE, 1981).

##### 3.7.1.2 Cinder Pit 3

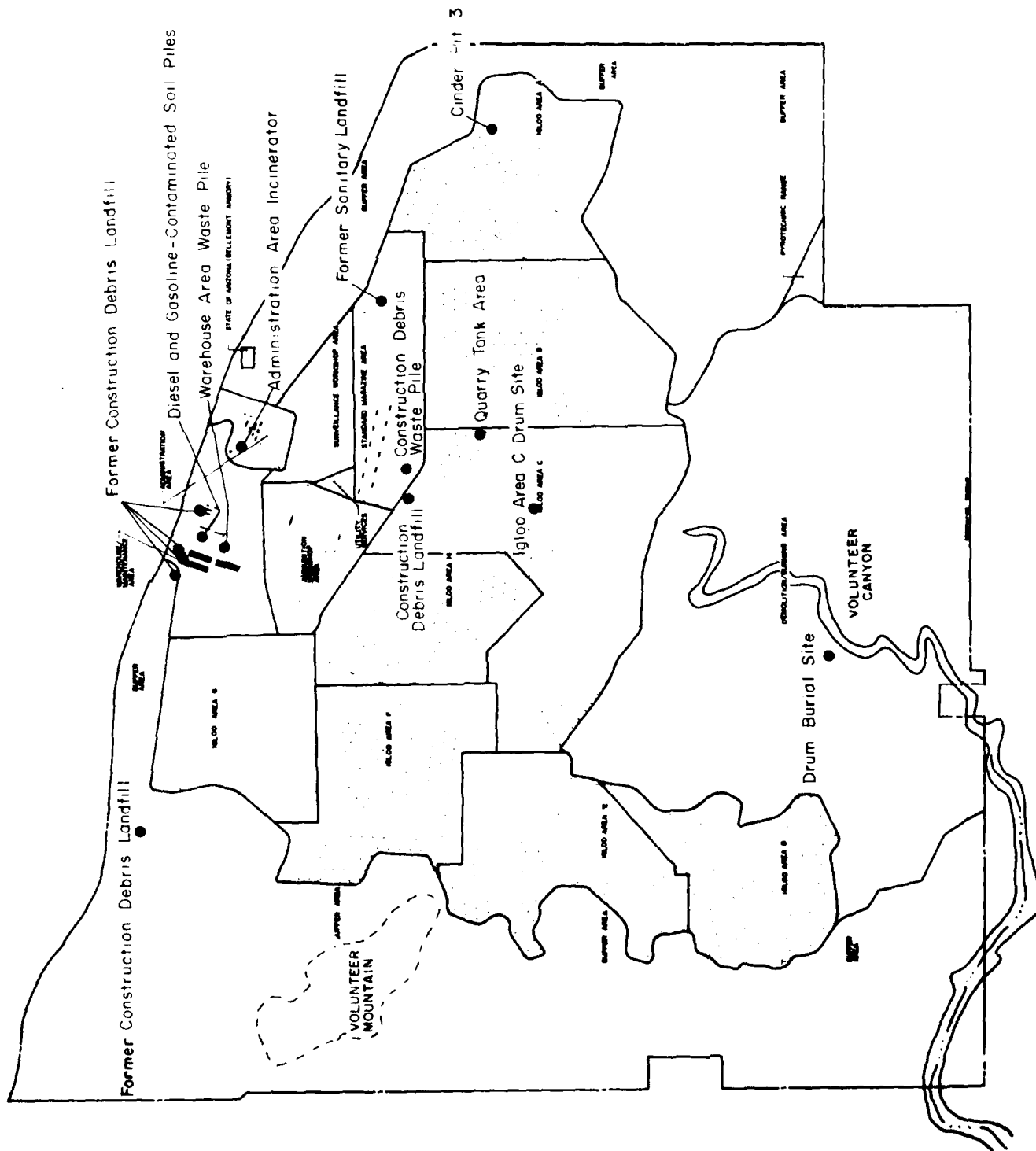
USAEHA (1987) has identified a former 1.2 acre landfill (NADA-16) on the northeast side of the road entering Cinder Pit 3 in Igloo Area A. The landfilled materials have been covered with cinders. Minor quantities of exposed waste include metal banding, metal parts, cable, wood, targets, one empty drum, and three empty gallon cans (USAEHA, 1987). Other wastes disposed in this landfill are undocumented. A former pistol range in Cinder Pit 3 is discussed in Section 3.4.2.

##### 3.7.1.3 Construction Debris Landfill

The current Construction Debris Landfill in the southwestern corner of the Standard Magazine Area has been in use since the late 1970s (Appendix B, Photograph 25). This landfill identified as NADA-25, (USAEHA, 1987) occupies a two acre site in a former limestone extraction pit. The pit has been partially filled with concrete, wood, bricks, reinforcing steel, empty cans and drums, cinder blocks, roofing shingles, steel banding, tires, aluminum materials, asphalt, and concrete practice bombs. Given the vintage of construction materials disposed here, it is likely that materials containing asbestos are also present at this site. This landfill does not require a permit under the Arizona Solid Waste Regulations (USAEHA, 1987).

# Legend

- Solid Waste Disposal Sites

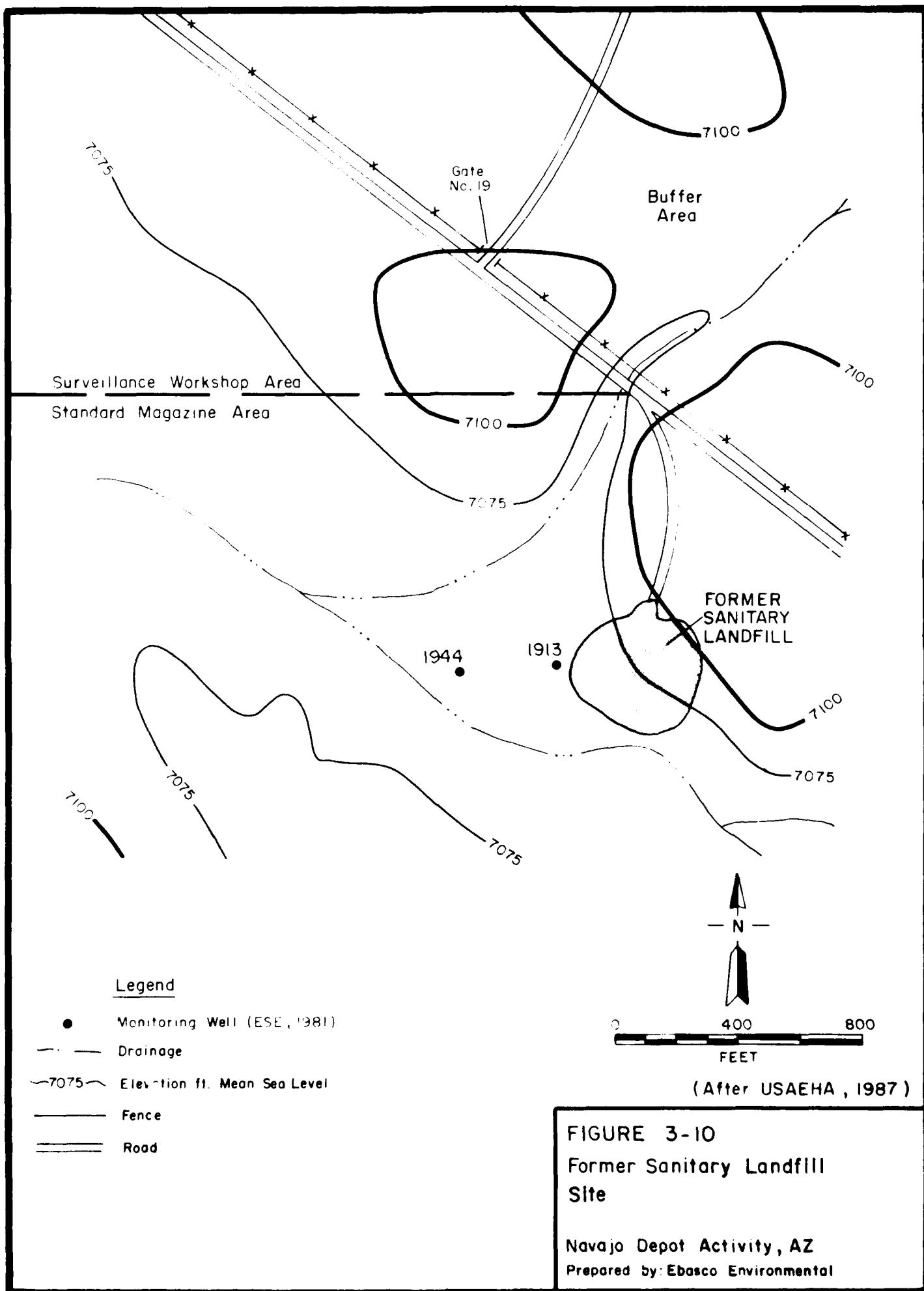


(Base from USACE, 1987)

FIGURE 3-9

Solid Waste Disposal Sites

Navajo Depot Activity, AZ  
Prepared by Ebasco Environmental



**FIGURE 3-10**  
**Former Sanitary Landfill**  
**Site**

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

#### 3.7.1.4 Former Construction Debris Landfills

Two former Construction Debris Landfills (NADA-27 and NADA-32) were identified based on air photo interpretation and subsequent site visits (USAEHA, 1987). They are located north of the Warehouse Area buildings and west of the former Indian Village, respectively. Both sites are covered with soil, but the following waste materials are still visible on the ground surface: wood, concrete, bricks, metal, glass, asphalt, roofing material, and tiles (Appendix B, Photograph 26) (USAEHA, 1987). Asbestos shingles can be seen at the landfill west of the Indian Village, and it is probable that asbestos-containing construction materials were also disposed in the Warehouse Area landfill sites because of the vintage of the materials placed in them.

#### 3.7.1.5 Drum Burial Site

NADA records of previously conducted employee interviews associated with the USATHAMA (1979) and ESE (1981) investigations indicate that a shipment of 20 to 25 barrels of a Navy material (possibly a herbicide or an acid) was brought from Guam to NADA in 1964 or 1965. The material was pumped from old drums to new drums in Parking Area I, the location of which has not been determined. The drums were subsequently buried with lime in the CK/CG venting portion of the Demolition Area (Figures 3-1, 3-9). It is unclear from the interview notes if only the old drums were buried, or if the new drums full of material were also disposed in this burial site. At a location suggested by a current employee, a probable mounded burial site marked with a large wooden post was found in the southwestern part of the CK/CG venting area (Appendix B, Photograph 27). A former employee had shown this site to the current employee and told him that this was where drums were buried (EBASCO, 1989b).

#### 3.7.2 Surface Waste Piles

##### 3.7.2.1 Quarry Tank Area

The Quarry Tank Area is located along the northern part of the boundary between Igloo Areas B and C. The area consists of three adjacent limestone quarry pits dating from NADA construction, aligned and numbered in sequence from north to south. Pit 1 of the three quarry pits is referred to as the Quarry Tank because it alone contains permanent water (Appendix B, Photograph 28).

Some waste materials have been dumped or piled into each pit. USAEHA (1987) numbered this site as NADA-15 and inventoried the wastes. Pit 1 contained many empty rusted drums marked "Smokeless Powder for Small Arms," wood, empty cans of various sizes, metal banding, a truck bed, and broken concrete with reinforcing bars. The Pit 2 area contained much banding, wire, metal stoves, and empty paint cans, and minor amounts of concrete, ammunition cans, and metal drums (Appendix B, Photograph 29). Pit 3 contained one steel cable and a minor amount of broken clay pipe (USAEHA, 1987).

A retired employee indicated that the quarries were excavated by the contractor who built NADA, and that much of the waste was dumped here at that time. The smokeless powder was used in blasting for constructing the igloos, and the stoves were from the construction worker's mess hall (EBASCO, 1989b). The waste is obviously very old and the site is not currently used for disposal activities.

Water in the Quarry Tank was sampled (ESE, 1981) and no contaminants were detected.

#### 3.7.2.2 Construction Debris Waste Pile

A construction debris waste pile site, NADA-24, (USAEHA, 1987) east of the STP evaporation lagoons consists of two piles approximately 60 by 60 ft and 25 by 25 ft (Figure 3-9). Exposed on the ground are roofing tiles, concrete, steel pipe, reinforcing wire, wood, roofing material, brick, and clay tile. This site is no longer used for construction debris disposal.

#### 3.7.2.3 Warehouse Area Waste Pile

This 70 by 160 ft waste pile, designated NADA-26, (USAEHA, 1987) is east of the GSA Warehouses and rests partially on a concrete pad and partially on the adjacent ground (Figure 3-9). The pile was inventoried as follows: concrete, soil, metal parts, fencing, an old boiler, metal lockers, metal storage cabinets, steel cable, wood, empty to partially full 55 gallon drums (four plastic and nine steel), two 20-gallon drums containing automotive grease, and numerous 5, 10, and 20 gallon buckets and drums that were generally empty (Appendix B, Photograph 30) (USAEHA, 1987). The time period for disposal at this site is unknown; it is not currently active.

#### 3.7.2.4 Diesel and Gasoline-Contaminated Soil Piles

In 1988, gasoline and diesel leaks associated with underground storage tanks in the Administration Area were discovered. This is discussed in Section 3.8.4. Contaminated soil excavated as a result of these incidents was piled on concrete pads in the Warehouse Area (Appendix B, Photograph 31). These pads are the foundations of previously demolished warehouses located east of the GSA Warehouses. The piles are periodically mixed to increase volatilization and biodegradation of the petroleum contaminants in the soil piles. When sampling indicates that contaminant concentrations have reached acceptable levels, a method for final disposal of these soil piles will be determined (NADA, 1988a).

#### 3.7.2.5 Igloo Area C Drum Site

A surface waste disposal site, in the eastern-central portion of Igloo Area C, was recently identified on the basis of personnel interviews (EBASCO, 1989b). The site is along a draw about 600 ft east of the railroad tracks (Figure 3-9) and was identified to be a potential place where PCBs were dumped.

There are two separate waste piles at the site. The first contains 27 empty five-gallon cans marked Thinner Dope and Lacquer Nitrate, five 1-gallon paint cans with one containing yellow paint, two empty drums, banding, metal debris, glass, wood, asphalt, rubber hose, plastic piping, an ammunition box lid, and possible asbestos-containing material (Appendix B, Photograph 32) (EBASCO, 1989b).

The second site is on the edge of the meadow and contains three 55-gallon drums (Appendix B, Photograph 33). Drums marked "kerosene" and "poison," respectively, are sealed. The third, marked "poison" and "weedicide," was open on one end and contained a small amount of some powdery substance. A lack of vegetation was observed in the immediate vicinity of the drums over a 20 by 20 ft area (Appendix B, Photograph 34) (EBASCO, 1989b).

### 3.7.3 Administration Area Incinerator

Structure 37 in the Administration Area is an incinerator that has not been used since the ANG took operational control of NADA in 1982. The incinerator has no burner and can only operate like a fireplace to burn combustible materials. On the basis of its construction, it is assumed that the primary function of the incinerator was to burn paper from the administrative offices, although the use history is not documented (EBASCO 1989b).

## 3.8 FACILITY-WIDE AREAS REQUIRING ENVIRONMENTAL EVALUATION

### 3.8.1 Asbestos

Asbestos has been identified in a majority of the buildings at NADA and is found surrounding steam lines, boilers, asphalt tanks, and as siding on buildings. Asbestos insulation is in disrepair in some locations. The Army completed a limited asbestos survey on a few buildings (EBASCO, 1989b). However, an asbestos survey for the entire base may be completed in 1990 by the USACE, pending the availability of funding. If not completed in 1990, then NADA will have to reapply to complete the survey at a later date (EBASCO, 1989b). The asbestos survey contingently planned for 1990 will locate, identify, and describe any asbestos or asbestos-containing materials found in buildings associated with equipment, heating systems, and piping between buildings, and assess existing or potential health hazards created by asbestos-containing material. The survey will also aid in recommending appropriate abatement measures, procedures, and cost estimates for each facility. The asbestos abatement project following the asbestos survey will reduce any potential employee health hazards (NADA, 1989a).

### 3.8.2 Polychlorinated Biphenyls (PCBs)

#### 3.8.2.1 PCB-Contaminated Transformers

PCB-contaminated transformers are defined in 40 CFR 761 as containing oil with 50-500 ppm PCBs. Five transformers fitting this definition are currently in operation at NADA (EBASCO, 1989b). One is located near the ANG WETS. Another is located north of the Administration Area near the access road leading into the restricted area. A third is located behind Building 301 in the Ammunition Workshop Area, and the last two are located behind the former Deactivation Furnace (Appendix B, Photograph 35). NADA has no PCB transformers, as defined by 40 CFR 761 as containing greater than 500 ppm PCBs.

According to hazardous waste manifests, PCB-containing materials have been transported off base. On June 3, 1987, three 25 KiloVolt-Amp (KVA), one 15 KVA, and three 5 KVA transformers, water contaminated with PCBs, debris contaminated with PCBs, and PCB oil were transported from NADA to the Grassy Mountain facility in Clive, Utah. On March 23, 1989, two 25 KVA, two 37.5 KVA, three 5 KVA transformers with a PCB concentration ranging from 98 to 280 ppm, one 37.5 KVA transformer with a PCB concentration of 4000 ppm, and one 7.5 KVA transformer with a PCB concentration of 710,000 ppm were transported from NADA to the DRMO Luke Annex in Glendale, Arizona (EBASCO, 1989b).

#### 3.8.2.2 PCB Releases to the Environment

According to information from former employees, two areas of potential PCB releases exist at NADA. A former employee told a current employee that PCBs were dumped at a site in Igloo Area C. The Igloo Area C Drum Site was described in Section 3.7.2.5 (EBASCO, 1989b). A different former employee reported that a PCB-contaminated transformer spill occurred in the the Ammunition Workshop Area. Two or three PCB-contaminated transformers that were stored across the road from the Deactivation Furnace, Building 334, had

settled into the ground and tipped over releasing PCB-contaminated oil. As stated in Section 3.5.1.1, there is also a slight possibility of PCB contamination in the Vehicle Maintenance Shop, Building 23. PCBs were formerly used as a component of hydraulic fluids and may be present from hydraulic fluid leaks or spills.

### 3.8.2.3 PCB Storage

There were potentially contaminated PCB transformers stored in Building S-18 (NADA 31). Lab results, however did not confirm high PCB levels in the transformers. Building S-18 also contains seven overpack drums, used PCB field kits (55-gallon drums), a remote control oil switch in a container, and sampling equipment used to sample the transformers (EBASCO, 1989b). Testing, replacement, and disposal of PCB items are budgeted in 1989-1992, but only funded in 1989 (NADA, 1989a).

### 3.8.3 Radon

A preliminary radon survey is proposed for April 1990 at NADA. The survey includes installation of 108 detectors (including quality assurance detectors) and is budgeted in 1990-1991. The survey will be conducted according to a priority list compiled by NADA personnel (Table 3-3). Sixty-nine Wherry housing units top the priority list. The most intensive survey will occur here, with lesser efforts concentrated on structures lower on the priority list (EBASCO, 1989b). The April 1990 survey results will be used to determine the scope of any radon abatement project. Any necessary radon abatement project will decrease resident and employee health hazards from radon and is budgeted for 1991-1993 (NADA, 1989a).

### 3.8.4 Underground Storage Tanks

#### 3.8.4.1 Location and Description

A site investigation was performed by Omaha District personnel on August 8, 1989, to inventory all known USTs at NADA (USACE, 1989). Nineteen USTs were inventoried (Table 3-4). They range in volume from 1000 to 15,000 gallons, and generally contain one of three products: fuel oil #2, diesel, or gasoline. Of the nineteen tanks inventoried, twelve are still in operation, three have been removed and not replaced, and four are no longer in use. Two 12,000-gallon USTs were removed from their location near Building 27, and these have been replaced with 15,000-gallon tanks. Three previously unknown USTs were identified in the survey: one at Building 217, a boiler; one at a fuel station, Building 218; and one found at an abandoned fuel pump island at an old CCC Camp (Appendix B, Photograph 36) (USACE, 1989). NADA also has two aboveground storage tanks northwest of Building 324, which formerly supplied the burner of the Deactivation Furnace. Their combined capacity is 800 gallons (NADA, 1988c). It is not known if unused USTs have undergone proper closure procedures.

#### 3.8.4.2 Leaks and Spills

The ADEQ asserts that all UST leaks are handled under the jurisdiction of the ADEQ UST program. This program derives its authority from Arizona Revised Statutes Title 49, Chapter 6, Underground Storage Tank Regulations (NADA, 1988b).

A program to test and certify the integrity of thirteen USTs has been proposed and is budgeted for 1989-1993. Investigation of a number of leaks has already occurred. A 1988 UST leak investigation at Building 316, the TNT Laundry Facility, revealed leaking plumbing and free product in soil (NADA, 1989a). The product has been removed from USTs at Building 316. Nearby groundwater was found to be contaminated by fuel-related organics (ESE, 1981).

**Table 3-3 Planned Radon Survey Locations**

**PRIORITY 1:**

Wherry Housing 69 Units

**PRIORITY 2:**

Building 2 (9,175 feet<sup>2</sup>) (3 Floors)

Building 3 (Post 1) (497 feet<sup>2</sup>)

**PRIORITY 3:**

Building 1 (12,869 feet<sup>2</sup>) (3 Floors)

Building 4 (4,118 feet<sup>2</sup>)

Building 6 (Post Chapel) (1,022 feet<sup>2</sup>)

Building 14 (7,496 feet<sup>2</sup>) (2 Floors)

Building 15 (Office) 1,800 feet<sup>2</sup>)

Building 16 (Office) (1,600 feet<sup>2</sup>)

Building 23 (16,727 feet<sup>2</sup>)

Building 24 (12,019 feet<sup>2</sup>)

Building 29 (Office) (1,66 feet<sup>2</sup>)

Building 30 (Work Area), (6,000 feet<sup>2</sup>)

Building 34 (4,222 feet<sup>2</sup>)

Building 35 (1,502 feet<sup>2</sup>)

Building 44 (1,600 feet<sup>2</sup>)

Building 209 (2,714 feet<sup>2</sup>)

Building 301 (Office) 1,000 feet<sup>2</sup>)

Building 310 (Work Area) (5,000 feet<sup>2</sup>)

Building 331 (Office/Lunch Room) (1,500 feet<sup>2</sup>)

Building 333 (430 feet<sup>2</sup>)

Building 7 (Post 3) (400 feet<sup>2</sup>)

Building 56 (Post 2) (450 feet<sup>2</sup>)

S9 through S13 Officers Family Quarters (1,134 feet<sup>2</sup> each)

**WETS**

101 (3,772 feet<sup>2</sup>)

102 (2,375 feet<sup>2</sup>)

103 (2,401 feet<sup>2</sup>)

104 (3,246 feet<sup>2</sup>)

106 (3,247 feet<sup>2</sup>)

107 (3,247 feet<sup>2</sup>)

108 (3,247 feet<sup>2</sup>)

109 (2,056 feet<sup>2</sup>)

111 (2,386 feet<sup>2</sup>)

113 (1,000 feet<sup>2</sup>)

Source: EBASCO, 1989b

Table 3-4 Underground Storage Tank Inventory

<u>Building</u>	<u>Function</u>	<u>Substances</u>	<u>Quantity (gallons)</u>	<u>In Use</u>
1	Depot Headquarters	Fuel Oil #2	1,000	yes
2	Firestation	Fuel Oil #2	1,000	yes
27	Fuel Station	Unleaded Gasoline	12,000 x 2	no (replaced)
27	Fuel Station	Unleaded Gasoline	15,000 x 2	yes
29	Elec. Gen. Plant	Diesel	1,000	yes
31	Fuel Station	Diesel	12,000	no (removed)
		Fuel Oil #2	10,000	no (removed)
203	Fuel Station	Gasoline	1,000	no (removed)
S-205	Fuel Station	Unknown	est. 10,000	no
217	Boiler	Unknown	est. 10,000	no
218	Gas Station	Unknown	unknown	no
243	Pumping Plant	Diesel	1,000	yes
		Fuel Oil #2	1,000	yes
302	Heating Plant	Fuel Oil #2	10,000	yes
316	Boiler Plant	Fuel Oil #2	10,000	yes
	Boiler Plant	Fuel Oil #2	7,500	yes
	Boiler Plant	Fuel Oil #2	5,000	yes
332	Boiler Room	Fuel Oil #2	2,000	yes
334	Deactivation	Fuel Oil #2	800	no
	Furnace (2 above ground tanks)			
--	CCC Camp	unknown	unknown	no

Source: USACE, 1989

ADEQ has requested a groundwater investigation. The study would determine the vertical and horizontal extent of contamination, propose remedial actions, and include soil borings and monitoring well installation (NADA, 1989a).

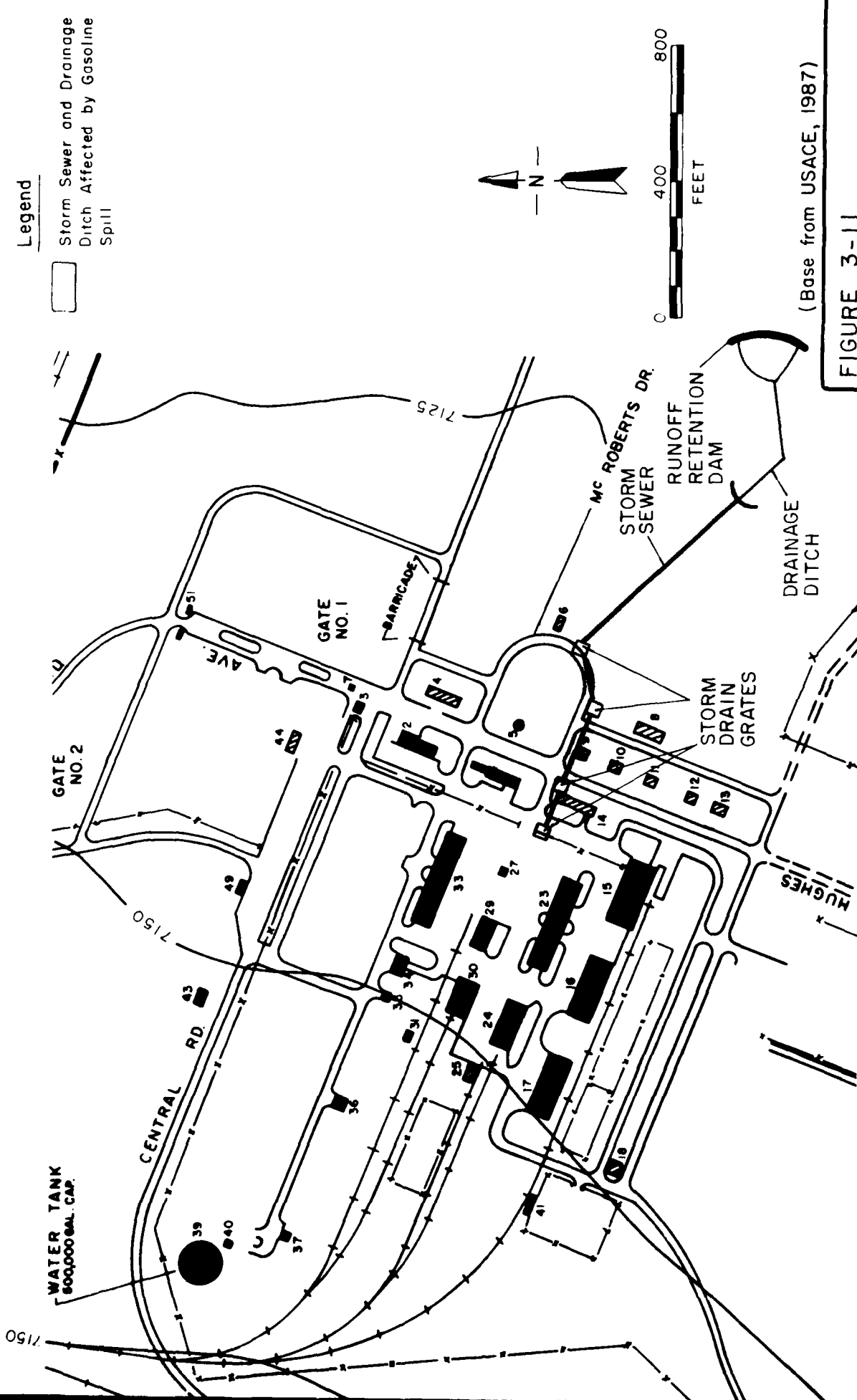
As stated in Section 3.2.2.1, soil beneath the Deactivation Furnace contains diesel fuel contamination ranging from 43 mg/kg to 5,550 mg/kg. This contamination was attributed to faulty underground service connections extending from two aboveground fuel oil tanks. A project is proposed to define the vertical and horizontal extent of diesel contamination and remediate the site. The funds for this project are included in the Ash Pile Closure contract.

An unleaded gasoline spill near Building 27 occurred while the gasoline was being pumped from the UST to a 5,000-gallon trailer. The gasoline also leaked beneath the dispensing pump. The soil around the plumbing became saturated with gasoline and then migrated through the soil into the storm drain system (Figure 3-11). After it reached the storm drainage pipe, the gasoline flowed approximately 1,000 ft through concrete pipes to an unlined drainage ditch southeast of the Chapel, Building 6. The fuel then flowed 500 ft along the ditch, volatilizing, and becoming trapped in the grass along the banks. An earthen runoff retention dam was constructed approximately 600 ft from the end of the storm drainage ditch to stop the flow (Figure 3-11). It was estimated that 576 gallons were lost (NADA, 1988a).

Another leak was discovered on April 10, 1988, when NADA personnel excavated the tops and sides of the diesel USTs next to Building 31 in order to measure them. Diesel-soaked soil was encountered along with pencil-sized holes in the fill pipes. It appeared that the fill pipes were responsible for the majority of the release. The contents of the diesel tanks were pumped into tank trailers on April 12, 1988, and the two tanks of 10,000 and 12,000 gallons were removed within seven days. The 10,000-gallon tank appeared to be in good condition, while the 12,000-gallon tank showed corrosion damage, including a leak at the end seam at the bottom. Up to 869 gallons of diesel fuel could not be accounted for. Both the gasoline and the diesel releases occurred less than three-fourths of a mile potentially upgradient of Reservoir 1, the Depot drinking water source. ADEQ has requested further investigations to define the extent of the soil contamination.

The soil surrounding the tanks showed the only significant contamination from the diesel and gasoline spills. Four areas of known or suspected contamination resulting from the spill are beneath the gasoline dispensing pumps east of Building 27, beneath the gasoline UST, beneath the diesel UST, and in the drainage ditch behind Building 6, the Chapel (NADA, 1988b). Eight samples collected June 2, 1988, from four locations east of Building 27 were reported not to contain contamination above ADEQ action levels. On July 6 and 7, 1988, three soil samples were collected from the drainage ditch east of the Chapel, four samples were collected north of Building 27 at the bottom of the gasoline UST excavation, and four samples were collected at the bottom of the diesel excavation northwest of Building 31.

The drainage channel and the diesel UST excavation sample results showed petroleum contamination above action levels. The results from the gasoline UST excavation showed no contamination remaining. On October 27, 1988, six samples were collected from the drainage ditch, and five samples were collected from the diesel UST excavation. Prior to this, 1 to 2 ft of soil were removed from the drainage channel. Also, the diesel UST excavation was extended down to the basalt bedrock in order to remove the contamination detected in July 1988. This contaminated soil was placed on a concrete pad in the warehouse area to aerate



(Base from USACE, 1987)

FIGURE 3-11

Gasoline Spill in  
Administration Area

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

and volatilize as was discussed in Section 3.7.2.4. The results of the analysis received to date showed all samples contained total petroleum hydrocarbons below 10 mg/kg. As of the date of the report, however, the total benzene, toluene, and xylene results had not been received (NADA, 1988b).

According to analytical reports, the potential for groundwater impact is considered to be negligible. As confirmation of this, results of water collected on May 2, 1988, downgradient of the site at Spring 1 and Spring 2 as well as from Wherry housing taps, showed all samples to be at or below detection limits for all analytes analyzed (NADA, 1988b). The springwater tests will continue on a quarterly basis to check for contamination.

Twenty-one 55-gallon drums of rinseate were generated when the gasoline tanks were steam cleaned in place prior to removal. The drums of rinseate were determined to be a regulated substance and were collected by a petroleum recycler under contract to DRMO (EBASCO, 1989b).

#### 3.8.5 Lead-Based Paint and Solder

Many of the structures at NADA were painted with lead-based paint. Some remaining lead-based paint supplies were shipped to DRMO at Lake AFB Annex in 1988 (NADA, 1988d). Because of the age of the facility, concerns of lead solder on the pipes supplying drinking water to the facility exist. However, in 1988 NADA tested water samples from each drinking fountain for lead and all were found to be below EPA standards (EBASCO, 1989b).

#### **4.0 KNOWN AND SUSPECTED RELEASES**

This section discusses all documented or known and suspected releases of contaminants to groundwater, surface water, soils, or air resulting from activities at NADA. For the purpose of this section, documented or known releases are those supported by analytical results or by well corroborated observations (e.g., observing contaminated soils during excavation of leaking storage tanks). Suspected releases are those that are considered probable based on site history, site configuration, and personnel interviews. Releases from both present and past activities are considered.

#### **4.1 RELEASES TO GROUNDWATER**

Migration of contaminants to shallow perched groundwater at NADA is generally inhibited by the low precipitation and high transpiration rate, and locally restricted by the presence of relatively impermeable clays in some soils. In local areas at NADA, migration of contaminants to shallow and deep groundwater is enhanced by fracturing in volcanic and limestone bedrock and karst features, such as sinkholes in limestone bedrock. Releases to groundwater have generally resulted from the disposal or leakage of liquid waste, which can migrate by percolation through the vadose zone to the water table.

##### **4.1.1 Known Releases to Groundwater**

- Release of leachate from the Former Sanitary Landfill in the Standard Magazine Area. Zinc and nutrient-related compounds have been detected in downgradient groundwater monitoring wells completed in shallow perched alluvial aquifer. (See Section 3.7.1.1).
- Petroleum products released to groundwater from underground storage tank at Building 316 (former laundry) in the Ammunition Workshop Area. Toluene and ethylbenzene were detected in a monitoring well completed in shallow perched alluvial aquifer. (See Section 3.8.4.2).
- Zinc, cadmium, and sulfate were detected in monitoring wells downgradient of Ammunition Workshops. Leaching to shallow perched alluvial groundwater from disposed materials is indicated. (See Section 3.2.3).

##### **4.1.2 Suspected Releases to Groundwater**

- Disposal of TNT-contaminated wastewater and other liquid wastes in the TNT Retention Ponds, Former OB Trenches, and possibly the Former OB Ponds in the Demolition Area prior to 1967. Wastewater potentially infiltrated through the vadose zone to groundwater. (See Section 3.1.2).
- Potential infiltration and intermittent direct drainage prior to 1967 through a sinkhole to deep groundwater in regional Coconino-Supai aquifer from disposal of liquid wastes in the Former TNT Wastewater Lagoons and Old Earth Reservoirs in the Ammunition Workshop Area. (See Section 3.2.1).

- Infiltration to the shallow perched alluvial aquifer of treated wastewater from the Sewage Treatment Plant Evaporation Lagoons and, prior to lagoon construction, from wastewater discharge to the Volunteer Canyon drainage. (See Section 3.5.3).
- Prior to 1971, the infiltration to shallow alluvial aquifer of untreated sewage and Imhoff Tank effluent held in the Indian Village Sewage Lagoons. (See Section 3.5.3).

## 4.2 RELEASES TO SURFACE WATERS

The low amount of precipitation and high evaporation rates characteristic of the climate, as well as the presence of karst features in limestone bedrock at NADA, limits the occurrence of permanent surface water to features associated with a discharging groundwater source. Surface water is, therefore, limited as a medium for storing and transporting contaminants. Releases to surface water are generally restricted to liquid discharges from facility operations or spill incidents.

### 4.2.1 Known Releases to Surface Waters

- Leaking gasoline flushed with water from the storm drains near Building 27 into a surface water drainage channel east of the Administration Area in April 1988 during pumping of a UST. The channel was dammed and the gasoline removed from water with absorbent socks. (See Section 3.8.4.2).
- Release of treated effluent from the Wastewater Treatment Plant to a tributary of Volunteer Canyon under NPDES Permit prior to completion of the Evaporation Lagoons in 1975. (See Section 3.5.3).
- Oil, grease, and water from steam cleaning operations at Building 23 discharged through the storm sewer to a drainage ditch east of the Administration Area prior to the installation of an oil/water separator for effluent. (See Section 3.5.1.1).

### 4.2.2 Suspected Releases to Surface Waters

- Intermittent releases prior to 1967 of wastewater from the TNT Wastewater Lagoons and the Old Earth Reservoirs in the Ammunition Workshop Area into surface waters draining to a nearby sinkhole or to a tributary of Volunteer Canyon. (See Section 3.2.1).
- Potential releases of soil contaminants to surface water from high runoff storm or snowmelt events in Demolition and Ammunition Workshop Areas. This may be more prevalent during seasonal and intermittent flooding in the sinkhole complex in the Ammunition Workshop Area.

## 4.3 RELEASES TO SOILS

Releases to soils are more common and more extensive than for any other environmental medium. Soil releases result from current and former facility activities and operations and from current and former hazardous materials storage and disposal.

#### **4.3.1 Known Releases to Soils**

- Soil detections of TNT, nitrate plus nitrite, and total phosphorus in the Former White Phosphorus Burn and Detonation Area. (See Section 3.1.1).
- High concentrations of TNT and detections of DNT, DNB, and tetryl in the Closed TNT Retention Ponds in the Demolition Area. (See Section 3.1.2).
- Detectable levels of HMX, RDX, tetryl, TNT, DNT, lead, and barium in the current Open Burning portion of the Demolition Area. (See Section 3.1.2).
- HMX, RDX, TNT, lead, and barium detections in soils around the Deactivation Furnace and Ash Disposal Pile in the Ammunition Workshop Area. This site is scheduled for RCRA closure work beginning in spring of 1990. (See Section 3.2.2).
- Detections of TNT, TNB, lead, and barium in soils from the former TNT Washout Plant, Former TNT Wastewater Lagoons, and the Old Earth Reservoirs in the Ammunition Workshop Area. (See Sections 3.2.1 and 3.2.3).
- TNT, TNB, and traces of fluoranthene, naphthalene, phenanthrene, and pyrene found in a soil sample next to the Former Sanitary Landfill in the Standard Magazine Area. (See Section 3.7.1.1).
- Observable dark oil stain coating the banks of a drainage ditch east of the Administration Area at the Storm Sewer Outfall from Steam Cleaning Operations at Building 23. (See Section 3.5.1.1).
- Observable asbestos in soils beneath the steam lines in the Ammunition Workshop Area and beneath oil tanks at the Former Asphalt Plant. (See Section 3.8.1).
- Petroleum products from leaking underground storage tanks or piping adjacent to Buildings 27, 31, 316, and 334. Contaminated soil near Buildings 27 and 31 was excavated and placed on concrete pads in the Warehouse Area. Diesel contaminated soil at Building 334 will be remediated as part of the Deactivation Furnace Closure in 1990. (See Section 3.8.4.2).

#### **4.3.2 Suspected Releases to Soils**

- Potential UXOs and/or TNT soil contamination in the Demolition Area, Old EOD Demolition Area, and the Pyrotechnic Range. (See Sections 3.1.1 and 3.4.1).
- TNT and other chemical residue from materials burned in all of the former burning sites in the Demolition Area. (See Section 3.1.2).
- Reported leak of sodium arsenite from drums temporarily held on Pad 3 in the Demolition Area in 1969. The spill was treated with lime. (See Section 3.1.2).

- Potential explosive-related compounds in soils at drain outlets from all igloos used to store conventional munitions. (See Section 3.3.1).
- Potential mustard breakdown products in soils at drain outlets from D200 series igloos. (See Section 3.3.2).
- Potential TNT and other chemical contamination around all buildings in the Ammunition Workshop and possibly the Surveillance Workshop. (See Section 3.2.3 and 3.4.1).
- Soluble inorganic salt residues from the surveillance testing of CK and CG munitions at the Former Chemical Laboratory in Igloo Area D. Possible contamination at chemical laboratory drain outlet from other chemicals. (See Section 3.4.1).
- Metals from bullets and casings in the former and current Firing Ranges. (See Section 3.4.2).
- Contamination from the dumping of battery acid outside Vehicle Maintenance Shop, Building 23, and the disposal of waste oil from Building 23 on cinder roads or in cinder pits. (See Section 3.5.1.1).
- Residue from evaporation and infiltration of effluent in the Sewage Treatment Plant Evaporation Lagoons and the former Indian Village Sewage Lagoons. (See Section 3.5.3).
- Sludge from sewage treatment deposited in the STP Sludge Drying Beds and in the sludge disposal area south of the Standard Magazine J-10. (See Section 3.5.3).
- Petroleum products at the former and current Asphalt Plants. (See Section 3.5.4).
- Mercury contamination in soils around the cracked foundation of the former Mercury Storage Warehouse (Building 231 or 233) in the Warehouse Area. (See Section 3.6.1).
- Potential pesticide contamination in soil at drain outlets from Igloo H118 from former waste pesticide storage. (See Section 3.6.2).
- Pesticide contamination from former outdoor storage of pesticides at Building 335 and former outdoor pesticide mixing at Building 331. (See Section 3.6.2).
- Tannin and asbestos dusts washed from GSA Warehouse (Building 240) to surrounding soil by a water main rupture. (See Section 3.6.4).
- Leaks and spills from the storage of waste oils, hydraulic fluids, fuels, antifreeze, paints, and thinners in the current and former Open Air Storage Areas. (See Section 3.6.5).

- Potential soil contamination from the disposal of asbestos containing materials in construction debris landfills and waste piles. (See Sections 3.7.1.3, 3.7.1.4, and 3.7.2.2).
- Possible contamination (herbicide or acid) from drums buried in the CK/CG venting portion of the Demolition Area. (See Section 3.7.1.5).
- Metals contamination from the large quantity of metal debris dumped in the Quarry Tank Area. (See Section 3.7.2.1).
- Potential soil contamination from metal debris, drums of automotive grease, and other unspecified drummed materials at the Warehouse Area Waste Pile. (See Section 3.7.2.3).
- Possible herbicide or PCB contamination from uncontained surface debris at the Igloo Area C Drum Site. (See Section 3.7.2.5).
- Potential spill of PCB-contaminated transformer oil north of the Deactivation Furnace (Building 334). (See Section 3.8.2.2).

#### 4.4 RELEASES TO AIR

Air releases at NADA have been associated with munitions demolition, demilitarization, renovation, and testing, vehicle and equipment maintenance, and routine facility operations.

##### 4.4.1 Known Releases to Air

- Emissions from current and former open detonation and burning activities in the Demolition Area. (See Section 3.1).
- Venting to the atmosphere of an unknown number of 500 and 1,000 pound CK and CG bombs in the Demolition Area in the early 1950s and possibly the middle 1960s. (See Section 3.1.1).
- Evaporation of small quantities of CK and CG during surveillance testing of munitions at the Former Chemical Laboratory. (See Section 3.4.1).
- Emissions from the diesel-fired former Deactivation Furnace during demilitarization of small arms ammunition, tracers, primers, detonators, delays, and fuzes. (See Section 3.2.2.1).
- Venting of fumes from painting and paint drying in the Paint Shop (Building 35). (See Section 3.5.2).
- Venting of fumes from painting and paint drying during former ammunition renovation activities in Buildings 301, 310, 321, 322, 325, and 327. (See Section 3.2.3 and Table 3-1).

- Emissions from three currently permitted boilers and numerous formerly operated boilers used to heat buildings at NADA. (See Section 2.6).
- Emissions from a coal-fired oil heater at the former Asphalt Plant (Building 207) and from the diesel-fired oil heater at the current Asphalt Plant in the Warehouse Area. (See Section 3.5.4).
- Volatilization of mercury from former spills in Igloo H-111 and at the former Mercury Storage Warehouse. (See Section 3.6.1).
- Emissions from the Former Sanitary Landfill when materials were burned prior to being covered by cinders. (See Section 3.7.1.1).
- Volatilization of hydrocarbons from gasoline and diesel-contaminated soil currently spread on concrete pads in the Warehouse Area for remediation. (See Section 3.7.2.4).
- Emissions from former operation of the Administration Area Incinerator. (See Section 3.7.3).
- Release of asbestos from insulation that is in disrepair. (See Section 3.8.1).

#### 4.4.2 Suspected Releases to Air

No other sources of air emissions are suspected other than those noted in Section 4.4.1.

## **5.0 PRELIMINARY ASSESSMENT CONCLUSIONS**

The following sections present conclusions regarding AREEs based on the information examined in conducting this enhanced environmental assessment. Discussions are presented by groupings of AREEs as used in Section 3.0. Areas with no known or suspected environmental problems are also identified. A concluding section summarizes and prioritizes environmental problems identified in the assessment, and discusses the impacts that continued usage or a change in land use may have on biota and cultural resources.

### **5.1 AMMUNITION DEMOLITION AREA**

Current open burning and open detonation activities are conducted at specific sites under controlled procedures as described in the RCRA Part B Permit Application for these activities. Environmental impacts from this ongoing mission are minimized by adherence to these standard operating procedures. Historical detonation and burning activities have occurred in numerous sites in the large Demolition Area under less controlled conditions. The following conclusions can be made about this area:

- Open Detonation has resulted in potential UXO contamination in the current Explosives Demolition Area, the Former EOD Demolition Area, and the land adjacent to these sites.
- The unstable gaseous nature of the chemical agents vented in the Former CK/CG Demilitarization Area make residual contamination here unlikely from this activity.
- Explosives-related compounds and/or metals contamination in the soil have been demonstrated by sampling in the Former White Phosphorus Detonation/Burn Area, the Closed TNT Retention Ponds, and the Current Open Burning Area. Seven former sites where open burning occurred have never been sampled, but it is likely that contaminants similar to those found in the Current Open Burning Area also exist in soils of the old burn sites.
- Soils at Pad 3 may contain sodium arsenite or resulting degradation products from a leak of this substance in 1969.
- Although the lack of perennial streams at NADA precludes a continuous migration pathway, high runoff from storm or snowmelt events could potentially wash surface soil contaminants from the Demolition Area to nearby Volunteer Canyon.
- Shallow groundwater monitoring wells installed in the Demolition Area were dry, so the existence or extent of groundwater contamination from sites in the Demolition Area is unknown.

Some minor soil and air releases will accompany ongoing demolition activities. Access is restricted and limits potential exposure from existing soil contamination. A change in land use of this area would require extensive site investigation and probable remediation.

## 5.2 AMMUNITION WORKSHOP AREA

The Ammunition Workshop, Building 301, and the less than truckload facility, Building 310, are the only active facilities in this area. Operations have included other numerous, now abandoned, shops that were involved in ammunition renovation and demilitarization activities. Conclusions for the Ammunition Workshop Area are as follows:

- Sampling has demonstrated widespread explosives-related compounds and some metals contamination in soils around the workshop buildings and in the Wastewater Lagoons and the Old Earth Reservoirs.
- Abandoned workshop buildings are potentially contaminated by TNT or other explosives-related compounds and metals. In addition, paints, acids, and other chemicals used in renovation operations may have left residual contamination in some of the workshop buildings.
- Elevated zinc, cadmium, and sulfate detections in downgradient shallow perched alluvial groundwater indicates potential leaching of materials from the Ammunition Workshop Area. Formerly leaking USTs in this complex that may have impacted the perched aquifer are discussed in Section 5.8.
- Although the lack of perennial stream flow prohibits a continuous migration pathway, surface water generated by high runoff events may transport solid and dissolved contaminants from the Ammunition Workshop Area to sinkholes which recharge the regional aquifer and also to the Volunteer Canyon drainage.
- The current Ammunition Workshop, Building 301, is likely directly upgradient of springs providing the base water supply, and uncontained releases from this facility could threaten this resource. However, there are few data about the hydrogeology in this area on which to base a groundwater pathway assessment.
- A plan for closure of the Deactivation Furnace and Ash Disposal Pile will be implemented in the spring of 1990. This work will remediate surficial soil contamination in this small area.

Human exposure to contaminants in the Ammunition Workshop Area is limited because most of the complex is no longer used and access is restricted to trained personnel. Investigation, closure, and remediation of all facilities including buildings and former waste lagoons would be required for unrestricted release of this land.

## 5.3 MUNITIONS STORAGE

Munitions storage igloos and standard magazines have been used for storage of conventional munitions, pyrotechnic materials, and chemical agents. Conclusions concerning these facilities are as follows:

- Igloos and magazines used for the storage of conventional munitions and pyrotechnic materials are potentially contaminated by explosive dust. Soils around igloo drains may also contain explosive-related compounds.
- There is no record of decontamination of the igloos used to store chemical munitions.
- D300 series igloos used to store CK/CG-filled bombs probably do not contain residual chemical contamination due to the unstable nature of these substances.
- D200 series igloos used to store mustard (H)-filled munitions, along with soils at igloo drains, may potentially contain breakdown products of this more persistent chemical agent.

Human exposure to potential contaminants in igloos is restricted. Only trained workers have access to these locked facilities for moving or testing of stored munitions. Releasing this land would require investigation and closure of the facilities.

#### 5.4 MUNITIONS TESTING AND TRAINING

Munitions testing was formerly conducted in several facilities and areas of NADA. Training activities are ongoing and are conducted in the Buffer Areas surrounding the central facilities of the base. In addition, Ordnance Units train in the Ammunition Storage, Workshops and Demolition Areas at NADA. Conclusions concerning these activities are as follows:

- The Former Chemical Laboratory in Igloo Area D is probably not contaminated by former surveillance testing of CK/CG samples due to the unstable nature of these volatile agents.
- The Pyrotechnic Range, formerly used for conventional munitions testing, is possibly contaminated with UXOs, explosives, and metals, although employee interviews state that all malfunctioned items were recovered or destroyed in place.
- The Surveillance Workshop Building (Building 331) is potentially contaminated by explosives-related compounds from former testing activities. It is unclear to what extent, if at all, surveillance or minor proof testing was conducted outdoors in the Surveillance Workshop Area.
  - Training activities are generally conducted so that significant environmental releases and impacts are avoided. One potential release is of metals to the current and former Firing Ranges from bullets and spent casings, although metal in these forms is generally not very mobile in the environment and poses little direct threat of exposure.

Potential for exposure is considered very low in these areas because of the general low impact and controlled conditions that governed former and current activities in these areas. Release of lands used for munitions testing and training would require investigation and closure of the Former Chemical Laboratory, Pyrotechnic Range, the Surveillance Workshop, and the Firing Ranges. Release of remaining Buffer Areas would require minimal investigation.

## 5.5 OPERATIONS FACILITIES

Operations facilities are located in the northern end of NADA and include the Maintenance Shops, the Wastewater Treatment Facilities, the Asphalt Plants, and the Former Hospital. Conclusions concerning these facilities are as follows:

- The procedures for storing, handling, and disposing hazardous liquids associated with the Vehicle, Locomotive, and Paint Shops in the Administration Area generally preclude uncontained releases to the environment. Small spills to soils surrounding these buildings and the former disposal of waste oils on cinder roads or in cinder pits at NADA are exceptions.
- Staining suggests that maintenance shop floors may be contaminated by leaks and spills of hazardous substances used in maintenance operations.
- Soil contamination is indicated by dark staining in the ditch at the Storm Sewer Outfall for Steam Cleaning Operations in the Vehicle Maintenance Shop (Building 23). An NPDES permit may be required for this discharge.
- The Sewage Treatment Plant and associated lagoons are operated in a standard manner and represent no inordinate potential for releases to the environment. The Former Sewage Lagoons for the Indian Village received only household waste and probably do not contain any residues of significant hazardous materials in soils.
- Soil contamination by spilled petroleum products is probable at both the former and current Asphalt Plants in the Warehouse Area.
- No records were found of sampling or decontamination of the former Hospital before conversion to a WET's barracks. Certain portions of the building may possibly contain contamination from solvent and heavy metals including mercury usage in past hospital operations.
- The maintenance shops and the asphalt plants are potentially located upgradient of the springs that supply water to NADA from a perched aquifer. Little hydrogeologic data are available on which to base a groundwater pathway assessment. Releases of hazardous materials from these facilities, which could percolate to the water table, may threaten these supplies.

The exposure of operations facility workers to hazardous materials in these areas is minimized by the required procedures for storing, handling, and disposing these materials. A sampling and closure plan would be needed for all operations facilities before the land could be released for unrestricted use.

## 5.6 HAZARDOUS MATERIAL STORAGE

Hazardous materials have been stored in various locations and facilities at NADA. Conclusions regarding potential releases from these are as follows:

- The remnant concrete pad and surrounding soils at the site of the Former Mercury Storage Warehouse are potentially contaminated by mercury from spills in this structure. The interior of Igloo H111 is also potentially contaminated from a mercury spill.
- The interior of Igloo H118 and soil surrounding igloo drains have probable pesticide contamination from spills or leaks of stored waste pesticides. Potential pesticide contamination of the Former Pesticide Storage Facility (Building 335) and surrounding soil has resulted from releases associated with storage in and around this facility. Soil near Building 331 may possibly be contaminated from outdoor pesticide mixing.
- Building 244, the current pesticide storage facility, requires the installation of power, water, spill control, and firewalls to meet Army storage standards and requirements for these materials.
- Igloos F306 and F307 have been certified as free of radioactive contamination from the former temporary storage of tritium in these structures.
- GSA Warehouses, Building 239, 240 and 241 and surrounding soils are potentially contaminated by uncontained tannin dust and asbestos fibers from storage of these materials.
- The storage of excess equipment and drummed waste from the maintenance shops has resulted in potential soil contamination from leaks and spills in the current and former Open Air Storage Areas. These yards are unbermed, gravel covered sites.
- Several of the hazardous waste storage facilities, including the Former Mercury Storage Warehouse, the Current Pesticide Storage Facility, the GSA Warehouses, and the Open Air Storage Areas are located potentially upgradient of springs that supply the base water system. Contaminants released to soils in these areas can potentially migrate through the vadose zone and contaminate the perched aquifer and ultimately the springs.

Potential exposure to humans is restricted to workers periodically accessing these hazardous waste storage facilities for routine operations. Release of these sites for unrestricted use would require investigation and closure of all facilities.

## 5.7 SOLID WASTE DISPOSAL

Disposal of solid waste has occurred in numerous sites at NADA by landfilling, surface waste dumping, and incineration. All landfills and burial sites at NADA were not engineered facilities, but rather operated in a primitive fashion (e.g., excavate a trench and backfill with native soil after waste emplacement). No liners or low permeability caps were placed at the sites. Except for two monitoring wells where sporadic samples were taken at the Former Sanitary Landfill, there are no groundwater monitoring programs. The following are conclusions about these specific sites:

- The Former Sanitary Landfill in the Standard Magazine Area has reportedly received waste oils, paints, medical waste, and sewage sludge in addition to trash and garbage. Limited sampling has shown explosives-related and burning-related compounds in nearby soil, and landfill leachate with zinc and nutrient compounds in the perched alluvial aquifer at this site.
- Cinder Pit 3 is the site of a small landfill containing undocumented materials. This site also served as the Former Firing Range for pistols and rifles and may contain metal contamination from bullets and casings.
- The Current and Former Construction Debris Landfills, along with the Construction Debris Waste Pile, probably contain asbestos materials. Buried asbestos does not pose any hazard as long as it is undisturbed, but the surface waste pile has probable uncontained asbestos materials.
- The Warehouse Area Waste Pile contains metal debris and drums of automotive grease and other unspecified materials that may have contaminated soils under the pile.
- The Quarry Tank Area contains large quantities of metal and other debris from construction of the Depot.
- The Drum Burial Site in the CK/CG Demilitarization Area is the probable location for the burial of drums contaminated by an unspecified material, possibly an herbicide or acid. It is unclear whether the drums were all empty or whether some may have been full when buried.
- Diesel and Gasoline Contaminated Soil Piles in the Warehouse Area are volatilizing petroleum products as part of the storage and landfarming treatment of these contaminated soils.
- Possible herbicide or PCB contamination exists in soils at the Igloo Area C Drum Site from uncontained surface debris.
- On the basis of its construction, the Administration Area Incinerator was likely used for burning paper materials, although its use history is not documented.

Uncontained materials at the Igloo Area C Drum Site may pose an exposure hazard to wildlife and humans, although access to the area is restricted to approved personnel. Exposure potential at other solid waste disposal sites is considered minor due to the nature of the materials, the restricted access, and the low level of activity. Unrestricted release of solid waste disposal areas would require investigation and closure plans for the sites discussed above.

## 5.8 FACILITY-WIDE AREEs

Facility-wide AREEs are areas of dispersed hazards about which the following conclusions are drawn:

- Asbestos has been used in construction materials or as an insulating material in many buildings at NADA. Asbestos insulation in several areas is presently in disrepair and is releasing to the environment. A comprehensive asbestos inventory has not been conducted.
- Five currently operating PCB-contaminated transformers on NADA have been identified and labeled. PCB-contaminated transformers that have been shipped off-post were formerly stored in Building S-18 in the Administration Area along with used PCB test kits. A potential spill of PCB-contaminated oil from transformers was reported to have taken place north of the Deactivation Furnace in the Ammunition Workshop Area.
- The levels of radon in structures have never been investigated at NADA. Installation of 108 detectors is scheduled for April 1990.
- Lead paint has been used in the past on buildings at NADA and could be exposed in buildings with children in the housing area. Remaining stores of lead paint were shipped out in 1988. Lead solder in pipes does not appear to be a problem based on sampling results for lead from all drinking fountains at NADA.
- Leaking of petroleum products from USTs or associated pipes has occurred at several locations on NADA. These include sites near Buildings 27, 31, 316, and 334. Faulty tanks and contaminated soils at Buildings 27 and 31 in the Administration Area have been removed. Contaminated soil at Building 334 is scheduled for remediation under the Deactivation Furnace closure in spring of 1990. Toluene and ethylbenzene have been detected in the perched alluvial aquifer near the unremediated tanks at Building 316 in the Ammunition Workshop Area.
- UST leaks of gasoline and diesel fuel at Buildings 27 and 31 in the Administration Area are potentially upgradient of the springs that supply water to NADA from a perched alluvial aquifer. Little hydrogeologic data are available on which to base a groundwater pathway assessment. Previous sampling of the spring water has shown no problems, but the hydrogeologic setting in the area makes the groundwater supplying the springs susceptible to contamination by any uncontained, mobile soil or vadose zone contamination, such as the petroleum products discussed above.

Potential hazards from radon, lead paint, and asbestos exposure exist around the facility. Surveys are scheduled for radon and asbestos. Limited activity at potential areas of PCB spills and UST leaks minimizes exposure potential from these substances. Land release for unrestricted use would require investigation and determination of any appropriate and necessary remedial action for facility-wide AREEs.

## 5.9 AREAS WITH NO KNOWN OR SUSPECTED ENVIRONMENTAL PROBLEMS

Based on information examined for this enhanced preliminary environmental assessment, areas having no known or suspected environmental problems have been identified and are illustrated in Figure 5-1. These areas are portions of the east and west Buffer Areas that, by virtue of their function as a buffer zone between sites of significant potential hazards and the reservation boundary, have remained free of known environmental problems. These areas could be considered for release based on environmental considerations. It should be pointed out, however, that if current missions such as demolition and munitions storage are to be continued at present locations, then the Buffer Areas would still be necessary as zones to shield bordering lands from the potential hazards of these munitions-related activities (e.g., potential explosion of an igloo of stored munitions).

## 5.10 CONCLUSIONS SUMMARY

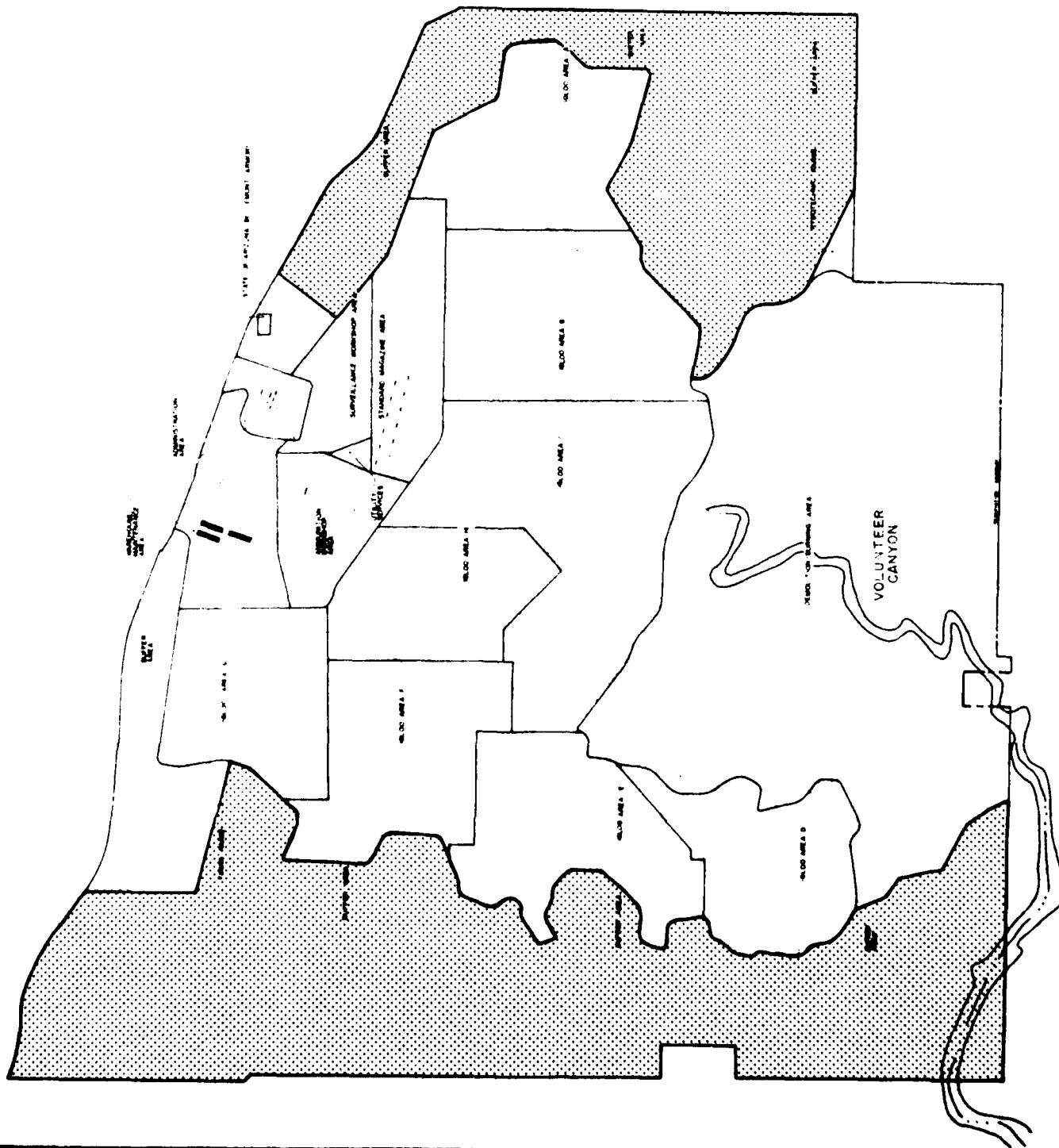
This enhanced preliminary environmental assessment has identified AREEs at NADA and characterized these areas with respect to their known and suspected releases of contaminants to the environment. Conclusions from this assessment have been discussed above by AREEs group, as in Section 3.0.

AREEs can be summarized by the section of NADA in which they occur. There are five areas where sites of concern are concentrated: the Administration/Warehouse Area, the Ammunition Workshop Area, the Standard Magazine Area, the Demolition Area, and the Igloo/Buffer Areas. Soil, and in some cases groundwater contamination have been demonstrated in these areas, but the degree and extent of contamination is still largely unknown and will require further investigation. The following is a contamination summary by area in a preliminary order of priority based on what is known:

- The Administration and Warehouse Areas are potentially located over the perched alluvial aquifer upgradient of springs that supply the base water supply. These springs are a valuable environmental resource and must be considered a high priority for protection from potential contamination. The Administration and Warehouse Areas contain numerous AREEs, including the Maintenance Shops, the Open Air Storage Area, the PCB Storage Building, the Asphalt Plants, the Current Pesticide Storage Facility, the Former Mercury Warehouse Pad, the GSA Warehouses, construction debris landfills, waste piles, and sites of leaking underground storage tanks. The occurrence of soil or groundwater contamination in this area is undefined because the only sampling has been soil sampling during excavation of leaking USTs.
- The Ammunition Workshop Area contains the former Deactivation Furnace and Ash Disposal Pile, the former TNT Washout Facility and Lagoons, other Ammunition Workshop buildings, a potential spill of PCB-contaminated oil, and two USTs with indications of leaks. Sampling in this area has demonstrated widespread soil contamination by explosives-related compounds and detections of contaminants in the perched alluvial aquifer. Only the current Ammunition Workshop (Building 301) is potentially upgradient of the base water supply springs. No sampling has been conducted at the current workshop.

# Legend

Areas with No Known  
Environmental Problems



(Base from USACE, 1987)

FIGURE 5-1

Areas with No Known  
Environmental Problems

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

- The types of materials disposed in the Former Sanitary Landfill in the Standard Magazine Area are not well documented. Interviews suggest that motorpool waste oil, waste paints, medical waste, and sewage sludge were discarded in addition to trash and garbage. Samples from the landfill area showed contaminants including explosives in soil and the presence of leachate in the alluvial aquifer.
- The Demolition Area contains numerous former demolition sites in addition to the current Open Burning and Open Detonation Areas. Limited sampling has shown soil contamination in three sites; most others have never been sampled. Monitoring wells in the Demolition Area were not completed to groundwater, so the potential for groundwater contamination is unknown.
- Remaining sites of concern are in the Igloo and Buffer Areas. These include surface waste piles, landfills, and igloo storage sites. Uncontained materials at the Igloo Area C Drum Site may pose an exposure hazard to wildlife and humans. None of these sites have been sampled.

In addition to specific sites, there are facility-wide problems that were also considered in this assessment. Potential hazards from radon and asbestos exposure exist at NADA and will be assessed under proposed surveys for these contaminants. Based on sampling results from drinking water fountains, lead solder in pipes does not appear to be a problem, but the hazard from lead-based paints is unknown.

If the result of Base Realignment and Closure for NADA is transfer to the public domain for unrestricted use, then all AREEs identified as known or suspected problems would require investigation and implementation of appropriate remedial actions. Unrestricted public use would also have implications for cultural and biota resources of NADA. The populations of game species and other animals would lose the protection of a fenced facility that restricts access for hunting and other potentially disruptive recreational uses. Archaeological and cultural sites would be accessible to the public and to the associated potential for plundering or vandalism. Because of restricted access, NADA functions as a preserve for these resources.

Approaches for addressing potential environmental problems at NADA depend on the end use of the land. It has been indicated that the probable result of Base Realignment and Closure will be continued use by the ANG. The recommendations presented in Section 6.0 are based on the assumption that the ANG will continue to operate NADA and that current missions and the current use of facilities will remain largely unchanged.

## **6.0 PRELIMINARY ASSESSMENT RECOMMENDATIONS**

Based on the information reviewed for this PA, NADA presents no imminent substantial hazard to human health or the environment. The Igloo Area C Drum Site does, however, contain a powdery waste in an open drum that could be potentially hazardous. Access to the site is restricted, so potential human exposure is limited, but wildlife exposure may be of concern. This site was recommended for immediate action to include installation of a fence and post warning signs around the area, conduct a site investigation, and overpack and remove any contaminated materials. Action to fence and post the site has been initiated.

The following actions are recommended to better characterize environmental conditions or to address known or suspected releases of contaminants to the environment. These recommendations are made with the assumption that the ANG will continue to operate NADA after Base Closure and Realignment. Abandoned and unused facilities should undergo investigation and proper closure activities. However, prior to release of NADA outside of the Department of the Army, investigation and remediation of all sites with environmental problems would be required.

Recommendations for facility-wide actions are as follows:

- Design and conduct a NADA-wide comprehensive baseline hydrogeologic investigation to gather sufficient data for an understanding of the complex hydrogeologic system. This should be done in order to properly place strategic monitoring wells at critical AREEs and prevent deterioration of the base water supply system.
- Conduct a comprehensive asbestos survey and plan and conduct remediation of problem sites.
- Continue with the scheduled radon survey and complete any necessary remediation to limit exposure hazard.
- Conduct an inventory or survey for lead paint, with emphasis on the housing area where an exposure risk for children may exist.
- Conduct a comprehensive UST survey to identify, locate, evaluate and close unknown USTs as well as the presently known USTs that have leaked.

The remainder of the recommendations are presented below according to the five geographic areas established in Section 5.10. Results from the above facility-wide actions may be used to alter the priority of the areas considered.

Recommendations for the Administration and Warehouse Areas are as follows:

- Develop and implement a comprehensive monitoring plan for the perched alluvial aquifer that supplies the springs for the base water supply. Many AREEs in the Administration and Warehouse Areas are potentially upgradient of the springs. Uncontained mobile soil and vadose zone releases from upgradient AREEs can potentially contaminate the groundwater.

- Investigation and closure of the Former Mercury Storage Warehouse Pad.
- Installation of power, water, spill control, and firewalls in the Current Pesticide Storage Facility (Building 244) to meet Army storage standards and requirements.
- Remove remaining waste materials from the former Open Air Storage Area and conduct an investigation and closure of this site.
- Improve the spill containment features of drum storage areas in the Vehicle and Locomotive Maintenance Shops and the current Open Air Storage Area.
- Investigation and closure of contaminated soils in the ditch at the Storm Sewer Outfall from Steam Cleaning Operations in Building 23. Determine if an NPDES permit is required for discharge from these operations, and if so, bring discharge into compliance.
- Investigation and closure of the Former Asphalt Plant site.
- Include GSA Warehouses, Building 239, 240, and 241, in the facility-wide asbestos survey because of former asbestos storage.
- Dispose of materials in the Warehouse Area Waste Pile to an appropriate landfill. Conduct an investigation and closure of this site.
- Add cover material to the Former Construction Debris Landfills to close these sites.
- Conduct an investigation including wipe sampling of the former Hospital prior to formulating a closure plan for this structure which has been proposed for demolition in the future as part of the WETS.

Recommendations for the Ammunition Workshop Area are as follows:

- Proceed with scheduled RCRA closure work at the Deactivation Furnace and Ash Disposal Pile, including fuel released from leaking service lines from aboveground fuel tank, to eliminate potential environmental releases from these areas.
- Investigate and develop a closure plan for the UST at Laundry Building 316.
- Investigation and closure of remaining abandoned Ammunition Workshop Buildings, lagoons, and surrounding areas to eliminate potential releases to surface water and the alluvial aquifer.
- Sampling and closure of the Former Pesticide Storage Facility (Building 335) and surrounding area.
- Investigate potential PCB spill site north of the Deactivation Furnace.

**Recommendations for the Standard Magazine Area are as follows:**

- Conduct regular (quarterly) sampling of existing wells at the Former Sanitary Landfill. Initiate additional soil and groundwater investigations and develop a closure plan for this landfill.

**Recommendations for the Demolition Area and Pyrotechnic Range are as follows:**

- Install functioning monitoring wells in the shallowest saturated aquifer zone encountered beneath the Demolition Area to assess the hydrogeology and the potential for groundwater contamination.
- Clear UXOs and sample for explosive and metal contamination in the Former EOD Demolition Area, the Pyrotechnic Range, and the area east of Volunteer Canyon adjacent to the current Explosives Demolition Area.
- Conduct sediment and surface water sampling in Volunteer Canyon during high runoff events to assess the potential for migration of dispersed soil contamination from the Demolition Area.
- Investigation and closure of Demolition Area sites no longer in use to limit the potential for contaminants to enter surface water or groundwater. These sites include the Old EOD Demolition Area, the Former WP Detonation/Burn Area, the Closed TNT Retention Ponds, the Former Open Burning Trenches, the Former Open Burning Ponds, Pad #3, the Former Propellant Burning Area, and the three Closed Open Burning Areas.
- Site investigation of the Drum Burial Site in the CK/CG Demilitarization Area to determine what was disposed and whether there are environmental releases that need to be addressed with a closure plan.

**Recommendations for the Igloo and Buffer Areas are as follows:**

- Conduct the immediate actions recommended at the beginning of this section for the Igloo Area C Drum Site.
- Investigation and decontamination of Igloo H118 and soil at the igloo drain outlet. This igloo was the Former Pesticide Waste Storage Facility.
- Investigation and sampling for mercury contamination in the interior of Igloo H111. Conduct proper closure based on findings.
- Investigation and decontamination of D200 series igloos and soil at igloo drain outlets. These igloos were formerly used to store mustard (H)-filled chemical munitions.

- Site investigation of the landfill and former pistol range in Cinder Pit 3 to determine if contaminant migration is a problem here. Conduct proper site closing based on findings.
- Dispose of surface debris waste piles in approved landfills or an appropriate manner. These sites include the Construction Debris Waste Pile, the Quarry Tank Area, and the Igloo Area C Drum Site.
- Conduct a visual inspection and surface sweep of Buffer Areas outside of the Firing Range and Pyrotechnic Range that have been used for training prior to unrestricted release. If continued use by ANG is foreseen, no action needed.

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# **Appendix A**

List of all Documents  
Reviewed for  
Navajo Depot Activity

Enhanced Preliminary Assessment

ADEQ Action Summary for NADA

1989

Photocopied 11/27/89

summary of actions taken and actions needed for NADA site

ADEQ Sample Plan for Navajo Depot Activity (3012 Plan)

Arizona Department of Health Services, Bureau of Waste Control

June, 1984

proposed sampling for ammo workshop, demolition area, old EOD demolition area, pyrotechnics area, and sanitary landfill area

ADEQ Sampling Results for Navajo Army Depot Activity

1984-1985

results from 1984 sampling program

Aerial Photographic Analysis of

Navajo Army Depot

Interim Report TS-PIC-89334-B

James D. Peroutky, Bionetics Corporation

September, 1989

historical and current areas of activity (ESOs) - 1959, 1974, 1978, 1988  
drainages  
railroads

Aerial Photography in

BIM Maps for Master Planning #1

Navajo Army Depot

Circa 1940s

Copied 12/1/89

shows oblique aerial views of NADA from 1940s - exact dates unknown

Air Pollution Control Operating Permit No. 84008-89

Three Boilers and 1236 Deactivation Furnace

Arizona Department of Environmental Quality

March, 1989

Air Pollution Control Operating Permit No. 84009-89

Open Burning and Detonation of Munitions

Arizona Department of Environmental Quality

March, 1989

Archeological Records Search  
Arizona State Museum  
December, 1989

Archeology of Arizona: A Study of the Southwest Region  
P.S. Martin and F. Plog  
1973

Arizona, A Geography  
M.L. Comeaux  
1981

Arizona Place Names  
University of Arizona General Bulletin 2  
W.C. Barnes  
1935

Award for Closure of Deactivation Furnace and Ash Waste Pile to  
OSCO, Inc.  
U.S. Army Engineer Division  
September, 1989  
contract specifications

Basic Information Maps for Navajo Depot Activity:  
Cantonment Area Land Use  
General Sanitary Sewer  
General Storm Drainage  
General Water Map  
Reservation Map  
Higginbotham and Associates  
March, 1987

Base Closure and Realignment Support Agreements Memorandum  
Navajo Depot Activity  
March, 1989  
listing of support agreements between NADA and other parties

Building Information Schedule  
Navajo Depot Activity  
September, 1989  
building information by building number

Burn Pad Soil Samples at NADA

Analytical Results

Tooele Army Depot

March, 1987

listing of results

CERCLA Facility Investigation

Inspection Report for Navajo Depot Activity

U.S. Environmental Protection Agency

April, 1982

ESO identification

sample results

Coconino County Assessors Office

Records for T21N R5E

Copied 11/27/89

Coconino National Forest Map

U.S. Department of Agriculture

August, 1985

Comments for Environmental Impact Statement Scoping Meeting

Base Realignment and Closure Program for Navajo Depot Activity

Arizona Department of Environmental Quality

June, 1989

Comments for Environmental Pollution Prevention Control and Abatement Report  
(1383)

Arizona Department of Environmental Quality

1989

exhibit 2 from 1383 report

Comment on Hazardous Waste Public Notice No. AZ7213820635

City of Flagstaff

October, 1989

Comments on Sampling Plan for Closure of the Popping Furnace and the Ash  
Storage Pile

Arizona Department of Environmental Quality

July, 1989

Comments on Underground Storage Tank Leak Investigation Report  
Arizona Department of Environmental Quality  
March, 1989

Contamination Evaluation for Navajo Depot Activity  
Contract No. DACA87-87-C-0086  
Final Report, Volumes 1 & 2  
Malcolm Pirnie  
March 1989

closure and design for deactivation furnace, ash disposal pile, & TNT lagoons  
geologic and hydrologic conditions

Contamination Evaluation and Design of Closures for Navajo Depot Activity  
Contract No. DACA87-87-C-0086  
Work Plan  
Malcolm Pirnie  
June 1988

background, sampling and design plans for closures listed in above entry

DARCOM Open-Burning/Open Detonation Grounds Evaluation for  
Navajo Army Depot Activity  
Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83  
U.S. Army Environmental Hygiene Agency  
September, 1981  
soil sampling OB/OD area

Deep Well Bore Log for Navajo Ordinance Depot  
C.W. Freelove Drilling Co.  
April, 1950

Deep Well Rehabilitation for Navajo Ordinance Depot  
Fisher Contracting Company  
May, 1978  
performance requirements and results of rehabilitation

Design of Closures for Navajo Army Depot Activity  
Contract No. DACA87-87-C-0086  
Malcolm Pirnie  
July, 1989

removal and closure designs for deactivation furnace, ash disposal pile, &  
diesel contaminated soil

Determination of No Residual Radiological Hazard in Igloos F306 and F307  
Department of Energy Letter  
November, 1980

Diesel and Gasoline Spill Update Memorandum  
Navajo Depot Activity  
July, 1988  
sample results from spill sites

Document Searches and Interview Files  
for 1979 and 1982 NADA Environmental Reports  
Navajo Depot Activity  
Reviewed 12/01/89

Documentation on Ownership of Forty Acre Land Parcel in Demolition Area  
Navajo Depot Activity  
December, 1989  
Quitclaim of interest by private party in Demolition Area land

Draft Final Remedial Action Plan  
Unleaded Gasoline Spill at Building 27  
Navajo Depot Activity  
May, 1988

Environmental Assessment for Weekend Training Site  
Draft Report  
Arizona Army National Guard  
August, 1988  
short sections on all environmental disciplines

Environmental Pollution Prevention Control and Abatement Report (1383)  
Navajo Depot Activity  
1989

Environmental Survey of Navajo Army Depot Activity  
Environmental Science and Engineering  
September, 1981

GW, SW, soil, and sediment sampling in ammo workshop, sanitary landfill,  
and demolition area  
history  
geology  
topography/drainage  
meteorology

Environmental Survey of Navajo Army Depot Activity  
Well Logs  
Environmental Science and Engineering  
1980

well logs for above survey

Evaluation of Solid Waste Management Units at  
Navajo Army Depot Activity  
Ground-Water Contamination Survey No. 38-26-0878-88  
Interim Final Report  
U. S. Army Environmental Hygiene Agency  
October, 1987

Solid Waste Management Units (SWMUs)  
geohydrology

Facility Management Plan for Navajo Army Depot  
EPA ID No. AZ7213820635  
Arizona Department of Environmental Quality  
October 14, 1988  
summarizes ESOs at NADA

Fish and Wildlife Annual Work Plan  
Fiscal Year 1990  
Navajo Depot Activity  
July 1989  
yearly summary of activities and budget

Fish and Wildlife Management Plan  
Navajo Depot Activity  
November, 1987

Forest Management Annual Work Plan  
Fiscal Year 1990  
Navajo Depot Activity  
July, 1989  
    yearly summary of activities and budget

Forest Management Plan  
Navajo Depot Activity  
November, 1987

General Land Office Surveys  
Township 21 North, Range 5 East, Gila and Salt River Meridian  
1878 and 1940-41  
    historical features

General Soil Map, Coconino County, Arizona  
U.S. Soil Conservation Service  
1972

Geologic Map of the Central Part of the San Francisco Volcanic Field, Northcentral  
Arizona  
by E.W. Wolf, G.E. Ulrich, R.F. Holm, R.B. Moore, and C.G. Newhall  
Miscellaneous Field Studies Map MF-1959  
USGS, 1987

Geology of the Woody Mountain Volcanic Field, Coconino County, Arizona  
K.S. Murray  
Unpublished Master's Thesis, Northern Arizona University, Flagstaff, AZ  
1974

Grazing Lease Management Annual Work Plan  
Fiscal Year 1990  
Navajo Depot Activity  
July 1989  
    yearly summary of activities, leases and budget

Health-Based Guidance Levels for Contaminants in Drinking Water and Soil  
Arizona Department of Environmental Quality  
June, 1989

Hydrogeological-Structural Analysis of the Woody Mountain Well Field Area with  
Geophysical Interpretations, Coconino County, Arizona

P.W. Scott

Unpublished Master's Thesis, Northern Arizona University, Flagstaff, AZ  
1974

Hydrogeology of Sources of Municipal Water, Flagstaff, Arizona

by E.L. Montgomery and R.H. DeWitt

Abstracts with Programs

Geological Society of America

Volume 6, Number 5, March, 1974

Installation Assessment of Navajo Depot Activity

Report No. 137

U.S. Army Toxic and Hazardous Materials Agency

December, 1979

past and current activities (ESOs)

history

biology

geology/soil/hydrology

meteorology

Installation Environmental Assessment for

Navajo Depot Activity

Inland Pacific Engineering Company

November, 1982

all environmental disciplines

Installation Hazardous Waste Minimization Plan

Navajo Depot Activity

July, 1989

brief history/mission

hazardous waste inventory/plans

Interim Remedial Action Report for Diesel and Gasoline Releases

Navajo Depot Activity

December, 1988

lists wells within 1/2 mile radius of spills

Interservice Support Agreement (ISSA)

USFPO for Arizona

May, 1982

agreement between National Guard and Army for operating NADA

Inventory of Federal Hazardous Waste Activities, 1988

Navajo Army Depot Activity

From ADEQ

Photocopied 11/27/89

lists ESOs

Inventory of Military Real Property

Navajo Army Depot

September, 1989

property descriptions by category

Investigation and Evaluation of Underground Storage Tanks at

Navajo Army Depot Activity

U.S. Army Corps of Engineers

September, 1989

16 USTs inventoried

soil maps and descriptions

Isotopic and Chemical Characterization of Groundwaters in the Vicinity of Flagstaff,  
Arizona

D.V. Wagner

Master's Thesis, University of Arizona, Tucson, AZ

1987

Land Management Plan

Navajo Depot Activity

November, 1987

land use inventory

soils survey

vegetation

wildlife

climatological data

recreation, water, and tree cover maps

License of NADA for National Guard Purposes (No. DACA09-3-82-153)

Department of the Army

May, 1982

license of Navajo Depot Activity to Arizona National Guard

Map Showing Geology, Structure, and Uranium Deposits of the Flagstaff 1° x 2°  
Quadrangle, Arizona

by G.E. Ulrich, G.H. Billingsley, R. Hereford, E.W. Wolfe, L.D. Nealey, and R.L.  
Sutton

Miscellaneous Investigation Series

U.S. Geological Survey

1984

Maps Showing Ground-Water Conditions in the San Francisco Peaks Area, Coconino  
County, Arizona - 1979

C.L. Appel and D.J. Bills

USGS Water Resources Investigations Open File Report 81-914

July, 1981

Mission Statement

Navajo Army Depot

Organizational Chart

Navajo Depot Activity

October, 1989

shows base organization

Pest Management Plan

Navajo Depot Activity

SGT Pablo Alvarez

November, 1989

Planned Program for Radon Detectors by Priority Category

Navajo Army Depot Activity

From CW2 Tom Hall, Safety Officer

Received 11/30/89

Preliminary Guidance for Fiscal Year 1988

Office of Emergency and Remedial Response

U.S. Environmental Protection Agency

1988

Preliminary Report of Investigation of Springs in the Mogollon Rim Region, Arizona  
by J.H. Feth, N.D. White, and J.D. Hem  
Open File Report  
U.S. Geological Survey  
June, 1954

Proposed Coconino County Comprehensive Plan  
Comprehensive Plan Committee  
November, 1989  
    planning goals and policies  
    population estimates

Public Land Order 59 and 176  
Reserving Public Lands Within National Forests for the Use of the War Department  
for Military Purposes  
U.S. Department of the Interior  
November, 1942

Public Notice of Intent to Deny a Permit for  
Incineration of Waste Munitions and Storage of Ash  
Arizona Department of Environmental Quality  
September, 1989  
    Denial of RCRA Part B Permit Application for Deactivation Furnace

RCRA Compliance Evaluation Inspection & Violations for  
Navajo Army Depot Activity  
U.S. Environmental Protection Agency  
September 1989  
    lists violations found

RCRA Part B Permit Application and Appendices for  
Navajo Depot Activity  
Open Burning/Open Detonation Areas  
Bellemont, Arizona  
Engineering, Design, and Geosciences  
October, 1988  
    OB/OD description and waste characterization  
    topography/drainage  
    land use/population  
    exposure assessments - GW, SW, noise, and air quality

Relation of Faulting to the Occurrence of Groundwater in the Flagstaff Area, Arizona  
by J.P. Akers

Article 39

Short Papers in Geology, Hydrology, and Topography

Geological Survey Professional Paper 450-B

1962

Report of Radioactive Materials Movement to Navajo Depot Activity, 29 September  
1979

TEAD Radiation Protection Officer

October 18, 1979

documents movement of tritium to NADA

Report on Transfer of Excess Land from Navajo Depot Activity to the U.S. Forest  
Service

U.S. Army, 1973

land transfer never completed

Sampling Program Results for 1986 at NADA

Tooele Army Depot

September, 1986

purpose of sampling not specified

Skin Reaction Incident Investigation Results

Navajo Depot Activity Memorandum

October, 1987

for grader operator in Demolition Area

Skin Reaction Incident Report

Navajo Depot Activity

July 1987

for grader operator in Demolition Area

Soil Gas Survey at the Navajo Depot Activity

Hydro Geo Chem

May, 1989

furnace and ash pile vicinity

Soil Survey of Navajo Army Depot , Coconino County, Arizona

U.S. Soil Conservation Service

1970

Spill Prevention, Control, and Countermeasures Plan  
Navajo Depot Activity  
July, 1988  
material storage summary

Storage of Radioactive Materials at Navajo Depot Activity  
Tooele Army Depot Memorandum  
1980  
decontamination and analysis descriptions

Structural Interpretations from Geomagnetic and Gravity Studies, Woody Mountain  
Well Field, Flagstaff, Arizona  
by P.K. Scott  
Abstracts with Programs  
Geological Society of America  
Volume 6, Number 5, March, 1974

Synopsis of Ground-water Conditions on the San Francisco Plateau near Flagstaff,  
Coconino County, Arizona  
by J.P. Akers, M.E. Cooley, and P.E. Dennis  
Open File Report  
U.S. Geological Survey  
June, 1964

Synthetic Organics Chemicals Survey for  
Drinking Water Wells at  
Navajo Depot Activity  
U.S. Army Environmental Hygiene Agency  
June, 1989  
water sampling results

Topographic Maps of Navajo Army Depot Activity  
Bellemont, Arizona Quadrangle  
1980

Tritium Related Newspaper Articles  
"Arizona Guard seizes tritium"  
"Tucson tritium delivered to Flagstaff depot" Arizona Republic, September 30, 1979  
"20 tons of seized tritium sealed in concrete bunker" Arizona Republic, October 1,  
1979

Uniform Hazardous Waste Manifests

Navajo Army Depot

1985-1989

manifest forms for several waste shipments

Water Resources of Southern Coconino County, Arizona

Arizona Department of Water Resources Bulletin 4

by E.H. McGavock, T.W. Anderson, O. Moosburner, and L.J. Mann

1986

Water System Compliance Status for FY-89 for

Navajo Depot Activity

Arizona Department of Environmental Quality

September, 1989

compliance notice and sampling results

Well Registrations and Water Level Data

Sections 20N 4E, 20N 5E, 20N 6E, 21N 4E, 21N 5E, 21N 6E, 22N 4E, 22N 5E  
and 22N 6E

Arizona Department of Water Resources

Copied 11/27/89

Woody Mountain Monitor Well Meeting Request to

Navajo Army Depot Activity

City of Flagstaff

November, 1988

Woody Mountain Monitor Well Meeting

Navajo Army Depot Activity Memorandum

November, 1988

Woody Mountain Well Monitoring System

Engineering Investigation and Design Services

City of Flagstaff Project No. 204-31

HDR Engineering

September, 1989

hydrologic conditions

potential pollution sources including NADA

WQARF Assistance Request

City of Flagstaff

July, 1987

WQARF Decision Record for Flagstaff Monitor Well System  
Arizona Department of Environmental Quality  
November, 1987

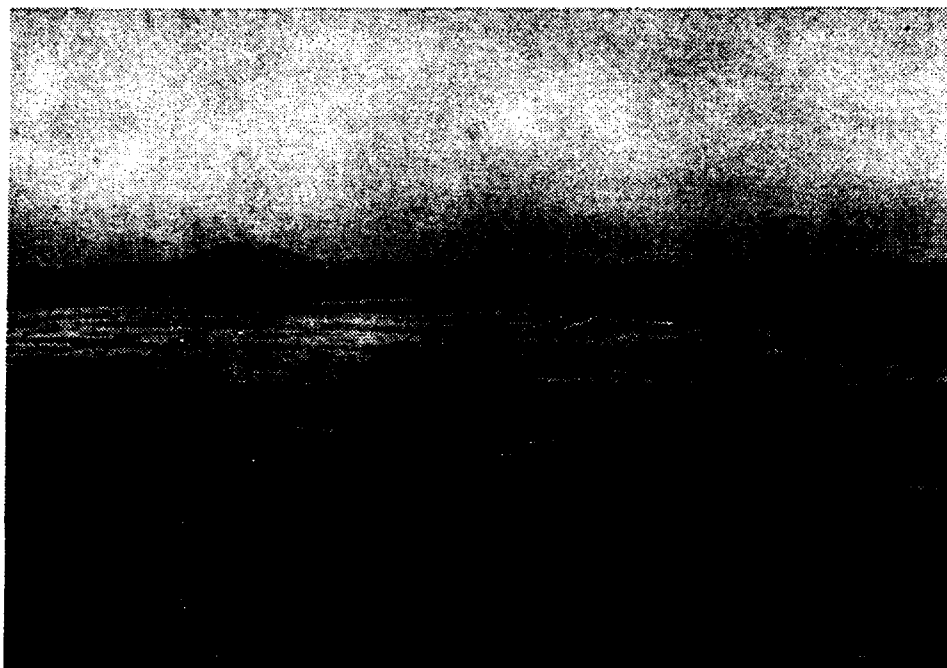
WQARF Notice to Potentially Responsible Party (NADA)  
Arizona Department of Environmental Quality  
September, 1978

WQARF Public Meeting  
Navajo Army Depot Activity Memorandum  
October, 1987

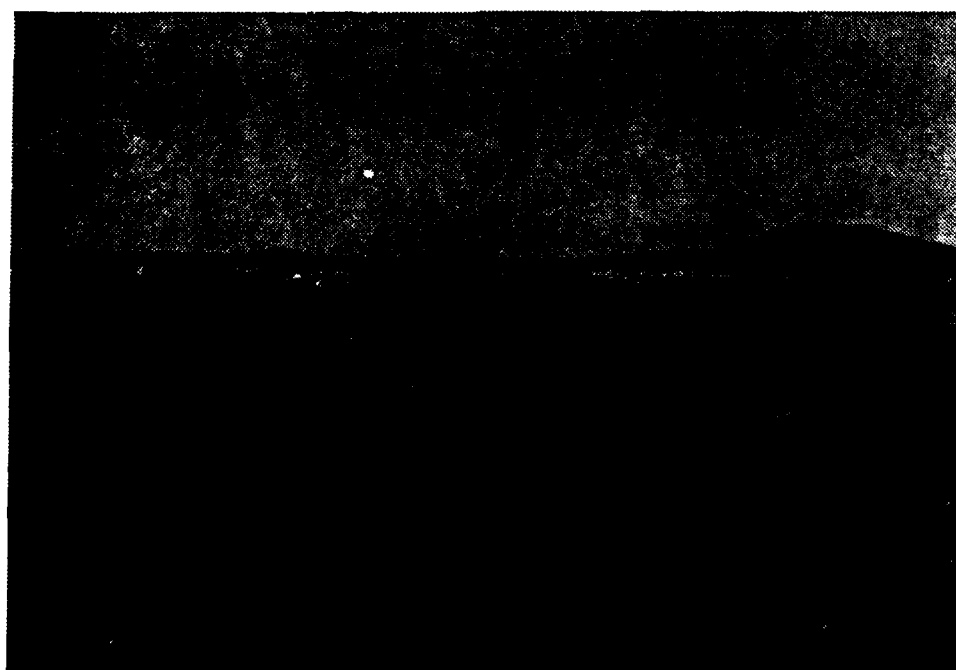
# **Appendix B**

Photographs of  
Navajo Depot Activity

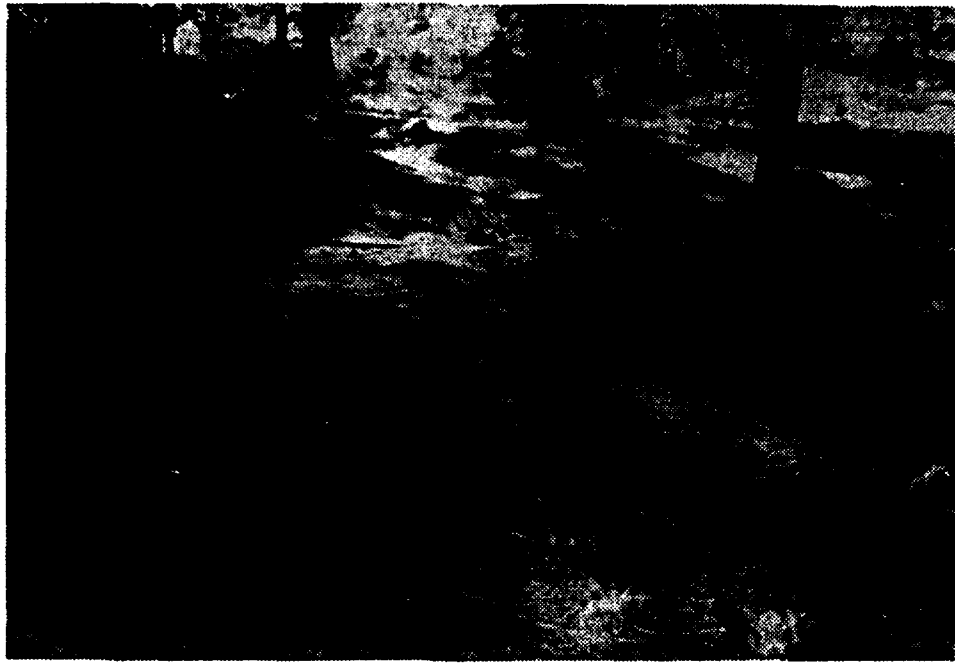
Enhanced Preliminary Assessment



1. View of NADA looking east from Volunteer Mountain



2. Sinkhole in Ammunition Workshop Area



3. Remnants of an old homestead site



4. Tin can pile at old homestead site



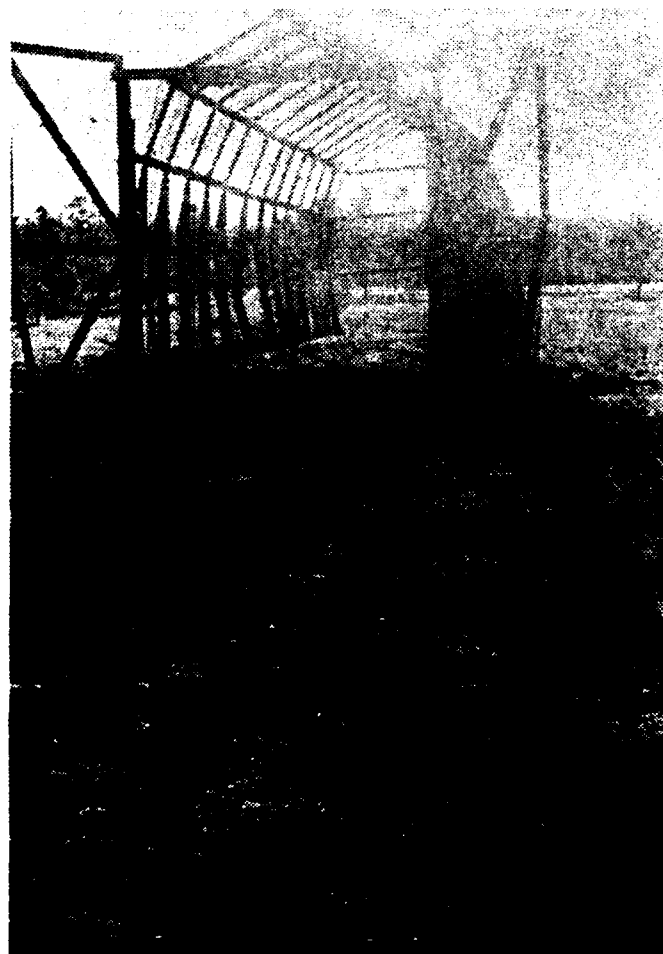
5. Area of ephemeral ponding called "Atherton Lake" in Ammunition Workshop Area



6. Open detonation pit in the Explosives Demolition Area



7. Former White Phosphorus Detonation/Burn Area in the Demolition Area



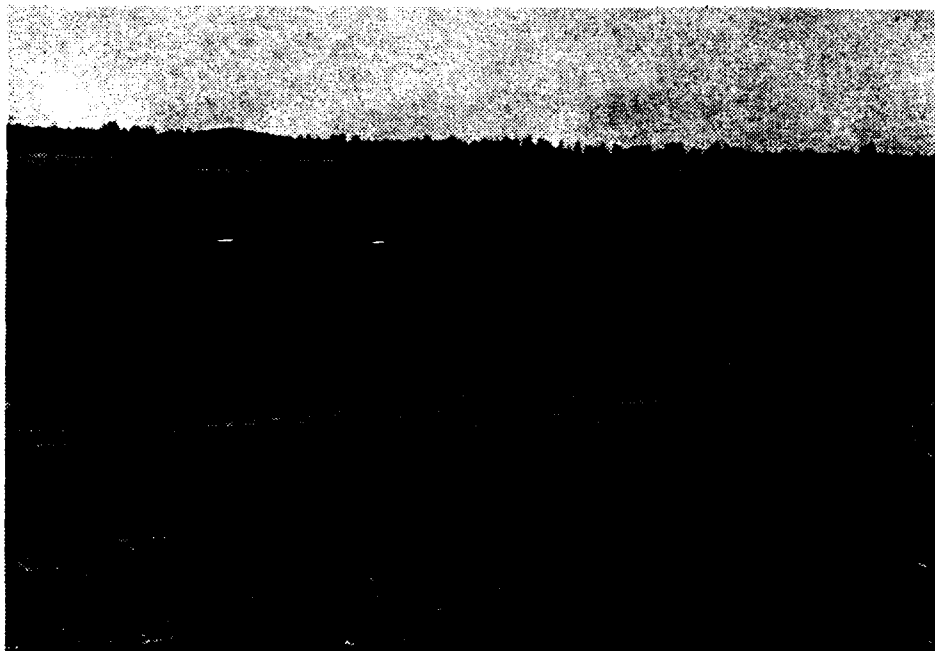
8. Old Burn Cage in the Open Burning Area of the Demolition Area



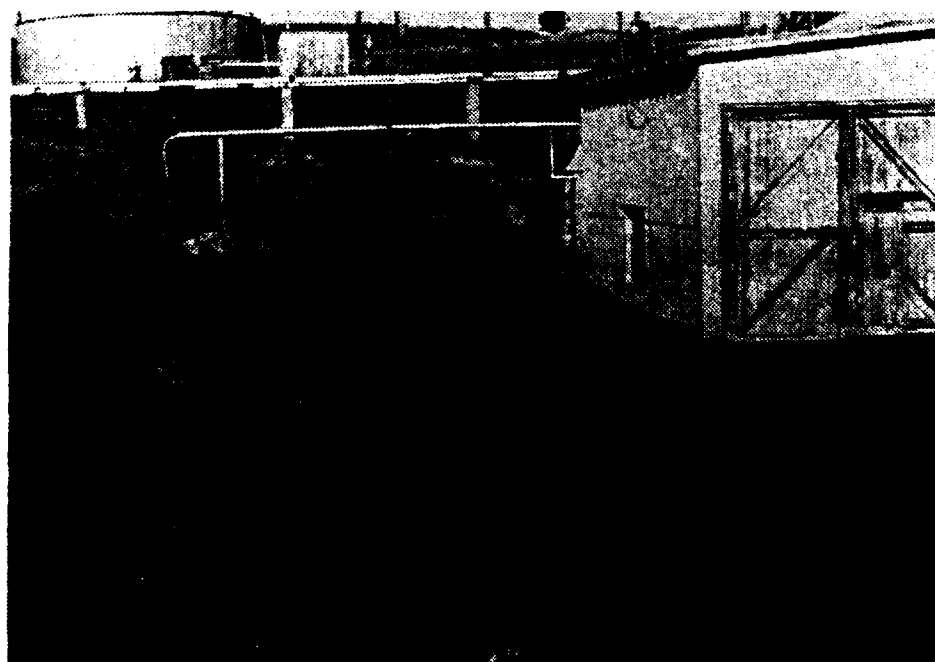
9. OB/OD Waste Pile and Burn Area in the Demolition Area



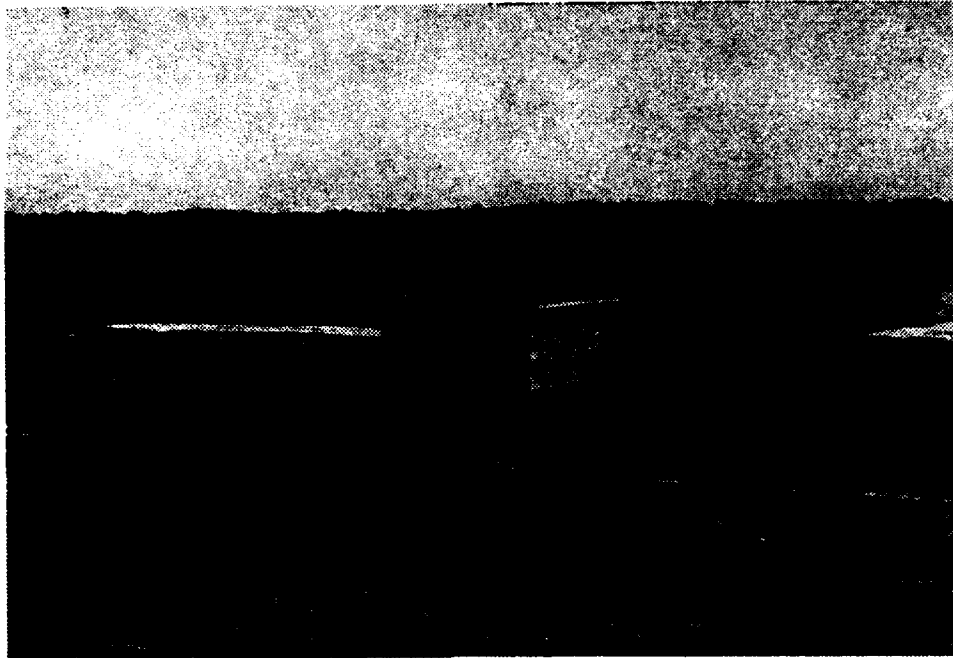
10. Location of USTs at the former Laundry Facility  
(Building 316) in the Ammunition Workshop Area



11. Lagoon for the former Laundry Facility (Building 316) in the Ammunition Workshop Area



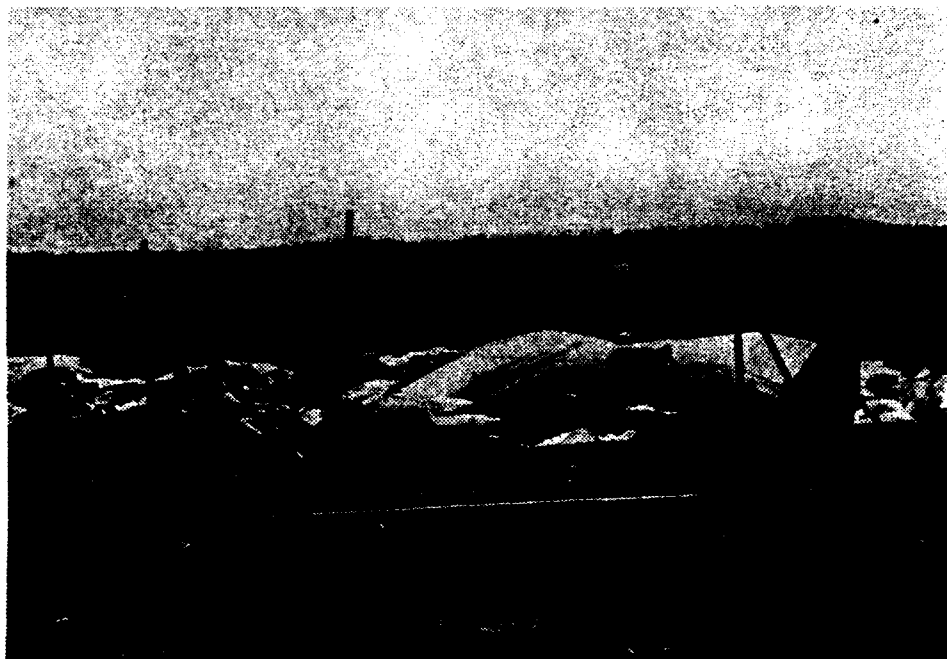
12. Former TNT Wastewater Recycling Facility  
(Building 319) in the Ammunition Workshop Area



13. Old Earth Reservoirs (background) in the Ammunition Workshop Area



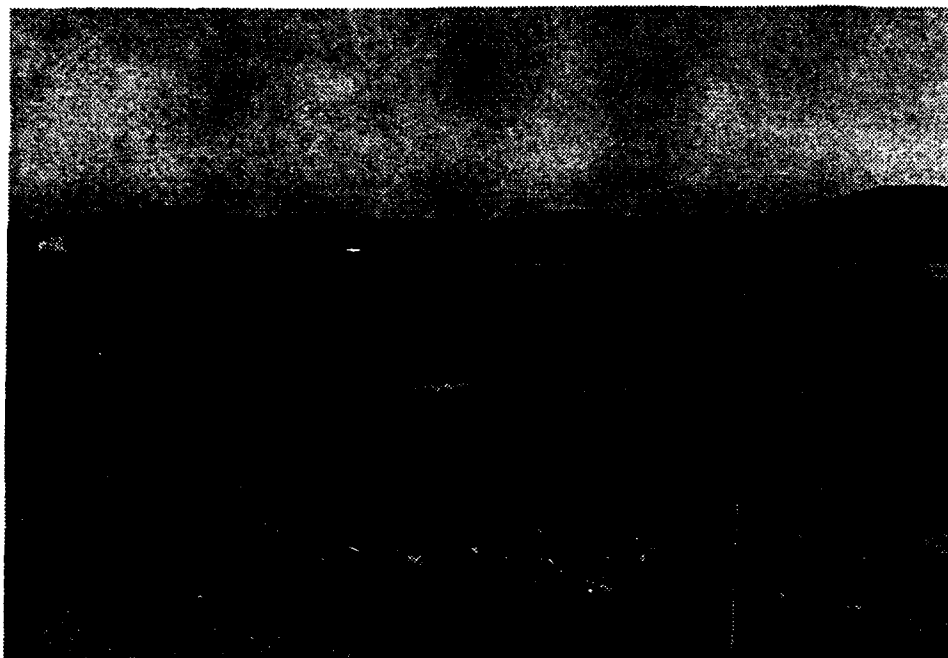
14. Former Deactivation Furnace Site in the Ammunition Workshop Area



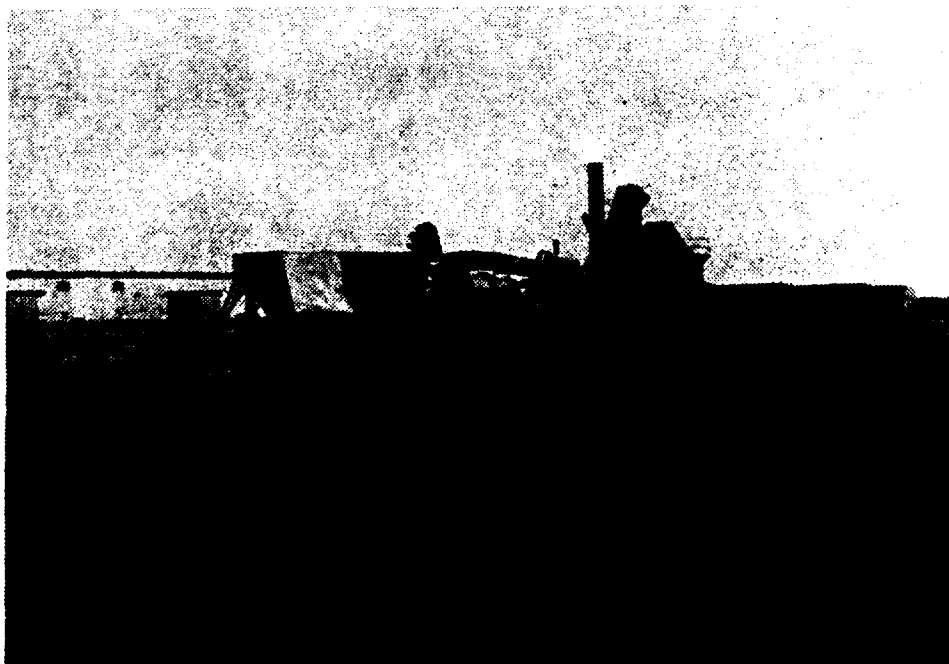
15. Covered Deactivation Furnace Ash Disposal Pile in the Ammunition Workshop Area



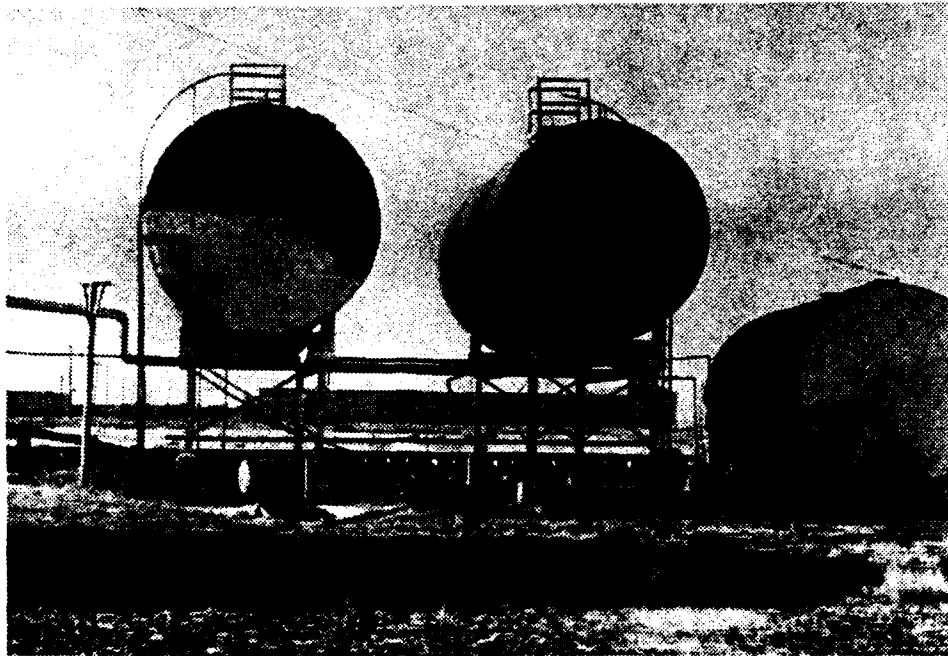
16. Sewage Treatment Plant Sludge Drying Bed



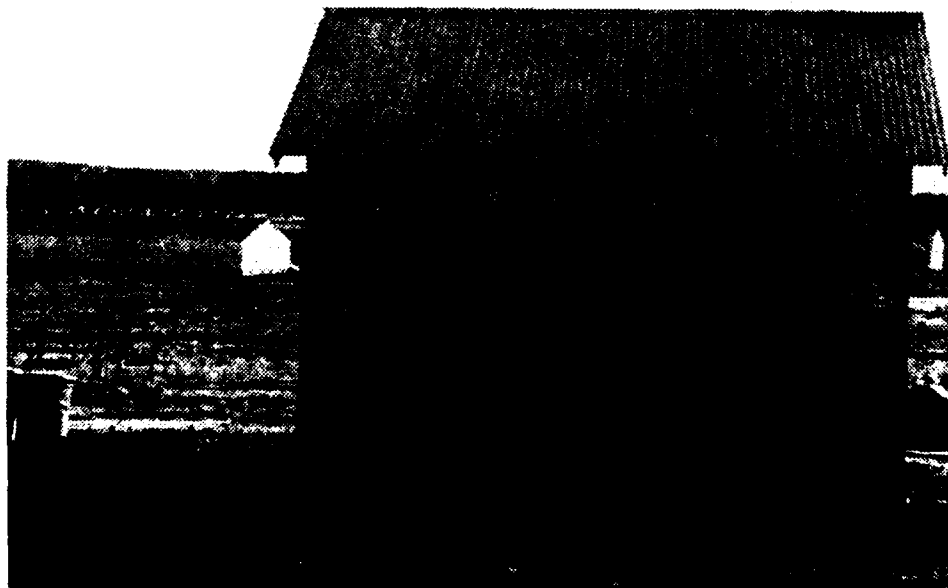
17. Sewage Treatment Plant Evaporation Lagoons ( Background)



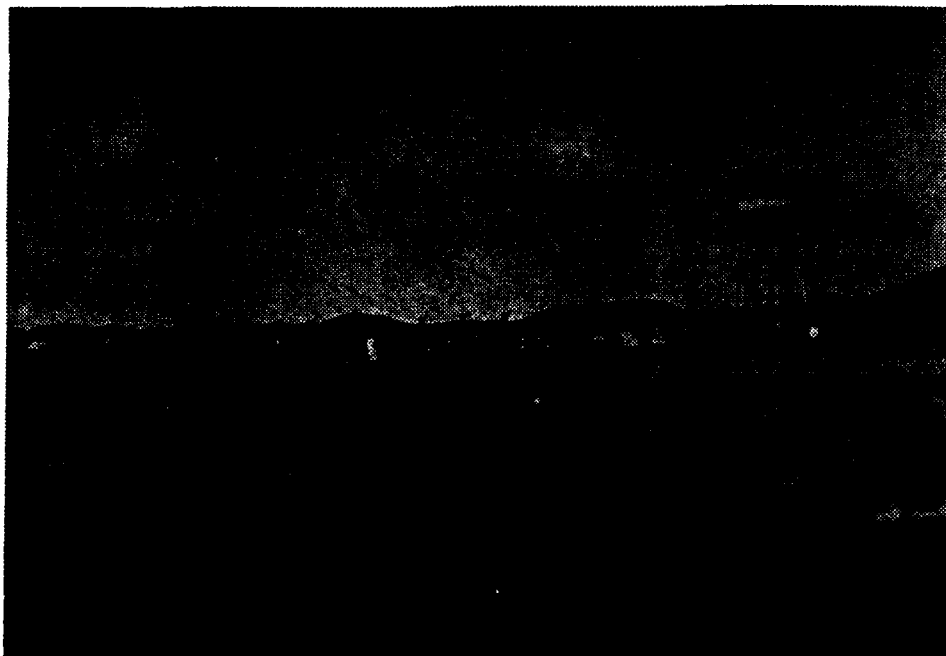
18. Current Asphalt Plant in the Warehouse Area



19. Asbestos insulation peeling from oil tanks at the former Asphalt Plant site



20. Former Pesticide Storage Building 335



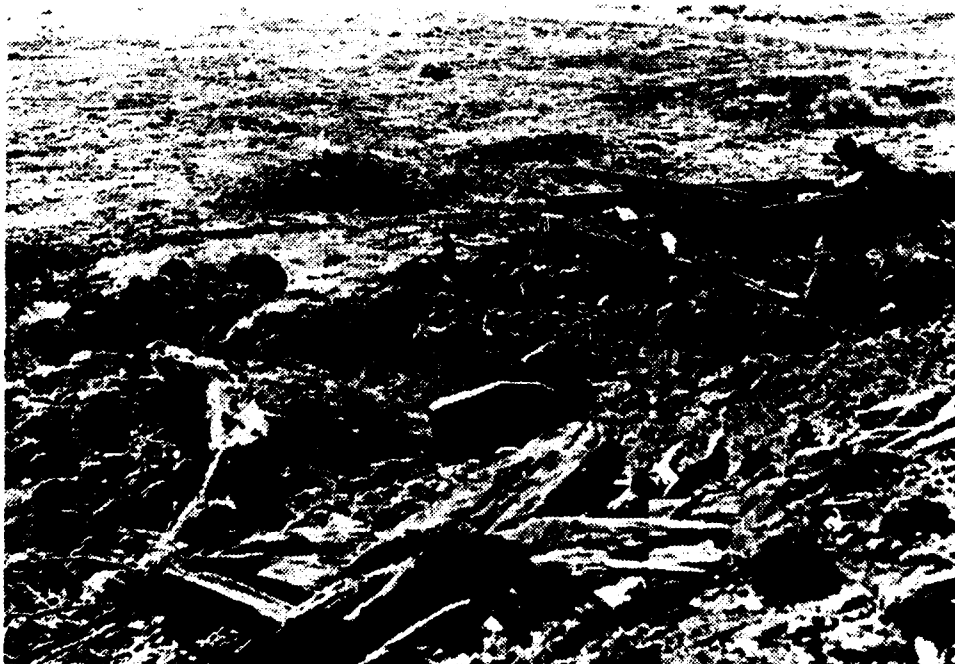
21. Current Open Air Storage Area in the Administration Area



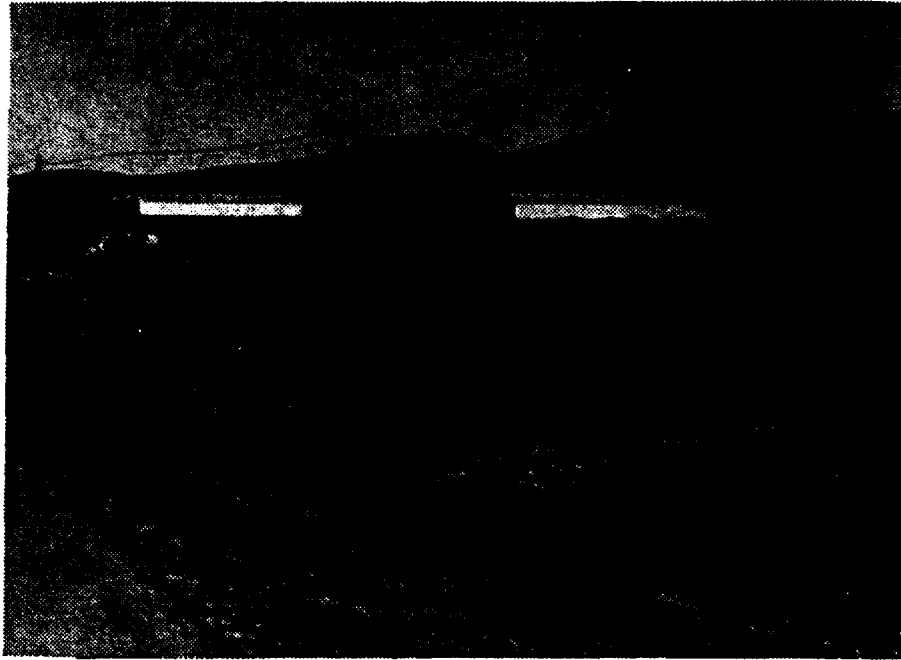
22. Former Open Air Storage Area in the Warehouse Area



23. Slipface between the upper lift and the lower lift at the Former Sanitary Landfill



24. Debris at the Former Sanitary Landfill



25. Current Construction Debris Landfill south of the Standard Magazines



26. Former Construction Debris Landfill in the Warehouse Area



27. Probable Drum Burial Site in the CK/CG Demilitarization Area of the Demolition Area



28. Quarry Tank Pit 1



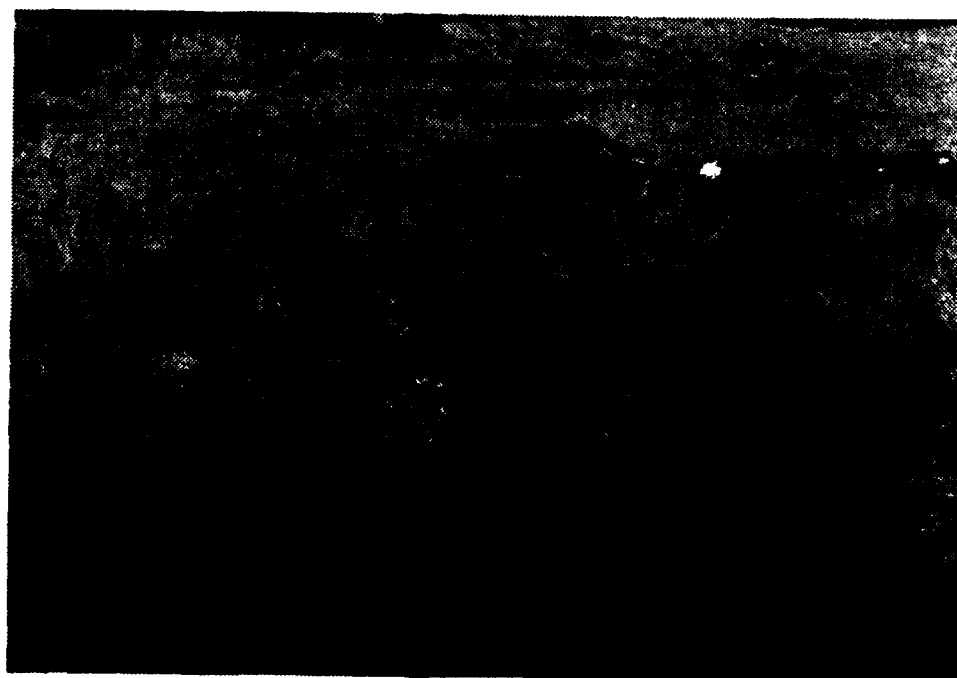
29. Quarry Tank Pit 2 with metal debris



30. Warehouse Area Waste Pile



31. Diesel and gasoline contaminated soil piles (background) in the Warehouse Area



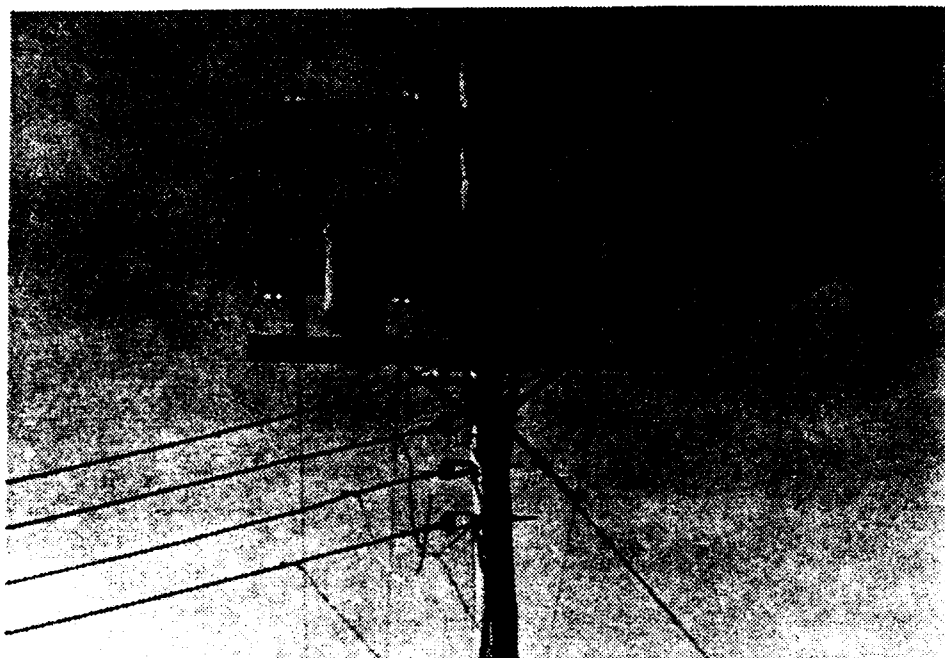
32. Surface debris at the Igloo Area C Drum Site



33. Igloo Area C Drum Site



34. Bare soil around open drum at Igloo Area C Drum Site



35. Transformer labeled as PCB-contaminated north of the Deactivation Furnace



36. Pipes of probable UST at former Civilian Conservation Corps site

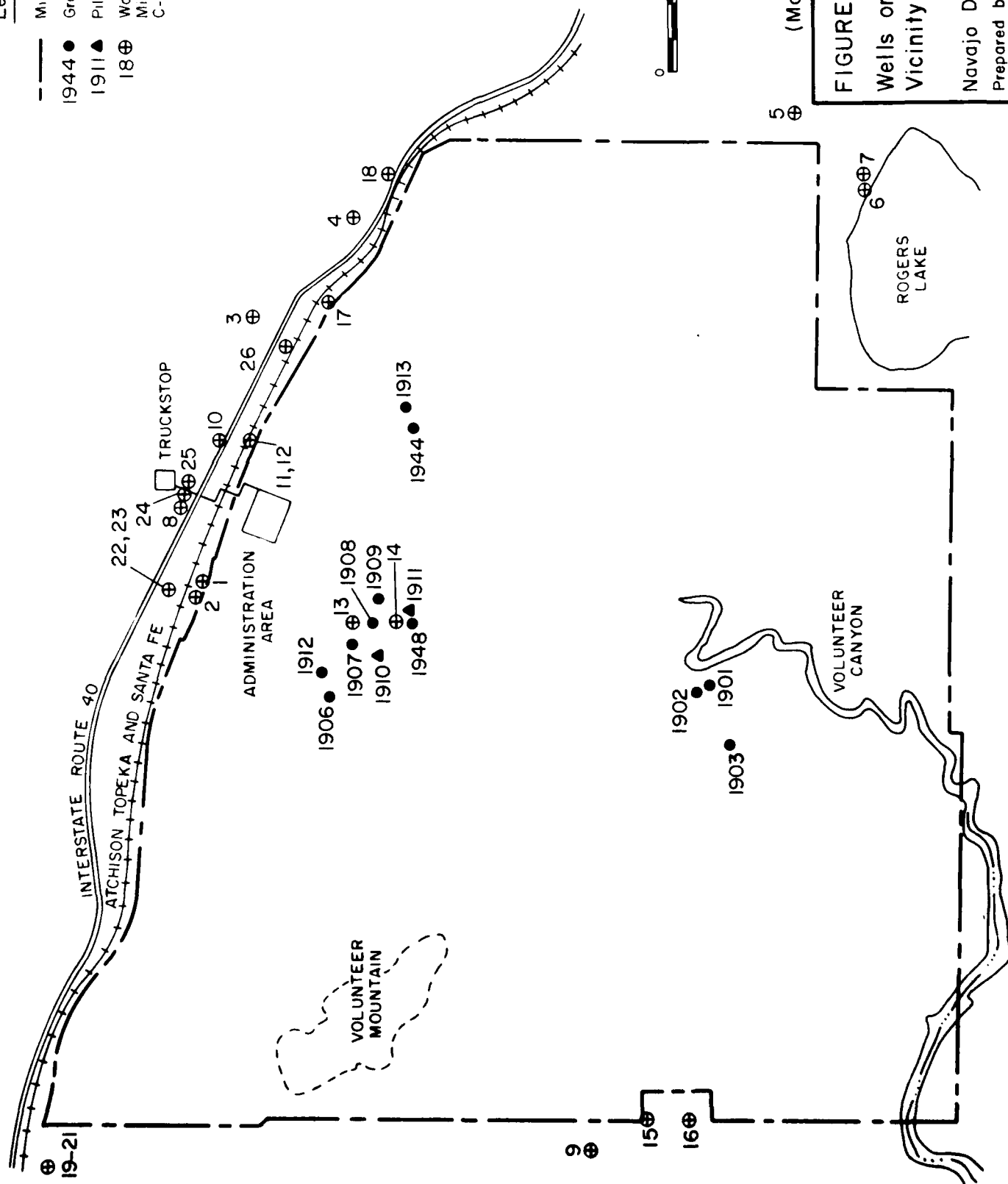
# **Appendix C**

Wells on and in the  
Vicinity of  
Navajo Depot Activity

Enhanced Preliminary Assessment

# Legend

- Military Reservation Boundary
- 1944 ● Groundwater Monitoring Well
- 1911 ▲ Pilot Boring/Piezometer
- 18 ⊕ Water Supply Well Within 1/2 Mile of Perimeter (See Table C-1 for Key)



(Modified from ESE, 1981)

FIGURE C-1

Wells on and in the  
Vicinity of NADA

Navajo Depot Activity, AZ  
Prepared by: Ebasco Environmental

TABLE C-1: NAVAJO DEPOT ACTIVITY, BELLEMONT, AZ - WATER SUPPLY WELL INVENTORY ON NADA OR WITHIN ONE HALF MILE RADIUS (1)

MAP	TOWNSHIP	RANGE	SECTION	QUARTER	QUARTER	REGISTERED	COMPLETION	WELL	WATER	WATER
NUMBER						OWNER	DATE	DEPTH	DEPTH	LEVEL
								FEET	FEET	DATE
										COMMENTS
1	21	5	2	ABC		SANTA FE RR	1929	110	16-36	1967-83
2	21	5	2	BAD		SANTA FE RR	1926	122	21	1943
3	21	6	6	DB		COCONINO NAT. FOR	—	—	—	—
4	21	6	8	—		D.W. HILL	—	—	—	—
5	21	6	28	CC		MILLER BROS.	—	—	—	—
6	21	6	32	ACC		MILLER BROS.	1900	16	16	1900
7	21	6	32	ADD		MILLER BROS.	1920	22	22	1920
8	22	5	36	CC		F.A. BOMKAMP	1960	65	55	1960
9	21	4	24	AAA		JOHN RYBERG	1988	200	150	1988
10	21	5	1	ACB		ACGT	1988	225	159	1988
11	21	5	1	ACC		C.G. CROCKATT	1986	100	42	1986
12	21	5	1	ACC		C.G. CROCKATT	1986	110	60	1986
13	21	5	11	BCB		AZ NAT. GUARD	—	—	—	IS LOCATION 21 5 2 DB?
14	21	5	11	CBB		AZ NAT. GUARD	—	—	1273	IS LOCATION 21 5 11 CBC?
15	21	5	19	CBB		K.H. JONES	1986	264	190	1986
16	21	5	19	CCC		K.H. JONES	1986	90	50	1986
17	21	6	7	BAA		MRS. T. RUTH	1988	147	90	1988
18	21	6	8	DBD		J.W. MYERS III	1983	370	300	1983
19	22	4	25	D		SANTA FE RR	1986	17	7	1986
20	22	4	25	D		SANTA FE RR	1986	20	DRY	1986
21	22	4	25	D		SANTA FE RR	1986	12	DRY	1986
22	22	5	35	CDD		W.W. BONES	1986	225	21	1986
23	22	5	35	CDD		W.W. BONES	1986	223	21	1986
24	22	5	36	CCD		L. MARTINSON	1987	105	22	1987
25	22	5	36	CDC		F. BOMKAMP WATER	1982	215	111	1982
26	21	6	6	CCA		A. CHOI	1949	200	19	1949

TABLE C-2: NAVAJO DEPOT ACTIVITY, BELLEMONT, AZ - MONITORING WELL INVENTORY (1)

MAP	TOWNSHIP	RANGE	SECTION	QUARTER	AREA MONITORED	COMPLETION DATE	WELL DEPTH (FT)	DIAMETER (IN)	WATER DEPTH (FT)	WATER LEVEL DATE
1901	21	5	27	NW	DEMOLITION AREA	1980	28	4	4	DRY 1980
1902	21	5	27	NE	DEMOLITION AREA	1980	28	4	4	DRY 1980
1903	21	5	27	NE	DEMOLITION AREA	1980	28	4	4	DRY 1980
1906	21	5	10	NE	AMMUNITION WORKSHOP AREA	1980	20	4	4	DRY 1980
1907	21	5	10	NE	AMMUNITION WORKSHOP AREA	1980	30	4	4	21 1980
1908	21	5	11	NW	AMMUNITION WORKSHOP AREA	1980	20	4	4	15 1980
1909	21	5	11	NW	AMMUNITION WORKSHOP AREA	1980	21	4	4	10 1980
1910	21	5	10	NE	AMMUNITION WORKSHOP AREA	1980	49	2	2	42 1980
1911	21	5	11	SW	AMMUNITION WORKSHOP AREA	1980	51	2	2	23 1980
1912	21	5	10	NE	AMMUNITION WORKSHOP AREA	1980	20	4	4	10 1980
1913	21	5	12	SE	FORMER SANITARY LANDFILL	1980	49	4	4	9 1980
1944	21	5	12	SE	FORMER SANITARY LANDFILL	1980	29	4	4	30 1980

## **Appendix D**

U.S. Fish and Wildlife Service  
Letter Concerning Potential  
Endangered Species at  
Navajo Depot Activity

Enhanced Preliminary Assessment



UNITED STATES  
DEPARTMENT OF THE INTERIOR  
FISH AND WILDLIFE SERVICE  
ECOLOGICAL SERVICES  
3616 W. Thomas, Suite 6  
Phoenix, Arizona 85019

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EBASCO ENVIRONMENTAL  
DENVER REGIONAL OFFICE

November 29, 1989

2-21-90-I-025

Terry W. Schulz  
EBASCO Services Incorporated  
143 Union Boulevard, Suite 1010  
Lakewood, Colorado 80228-1824

Dear Mr. Schulz:

This responds to your request of November 21, 1989, for information on species listed or proposed to be listed as threatened or endangered that may be in the vicinity of the Navajo Depot in Coconino County, Arizona.

Our data indicate no listed or proposed threatened or endangered species in the area of interest would likely be affected by the proposed action. We would like to bring to your attention a candidate category 2 plant species, Arizona leatherflower (Clematis hirsutissimus var. arizonicus) that has been reported from the Depot area. Category 2 species are those for which we do not have sufficient information to support their listing as endangered or threatened at this time, nor are they protected under the Endangered Species Act. Information on their presence is provided for your planning purposes only.

If we may be of further assistance, please contact Ms. Lesley Fitzpatrick or me (Telephone: 602/261-4720).

Sincerely,

Sam F. Spiller  
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico  
(FWE/HC)  
Director, Arizona Game and Fish Department, Phoenix, Arizona